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# Manufacturing PLANBOOK: 1975

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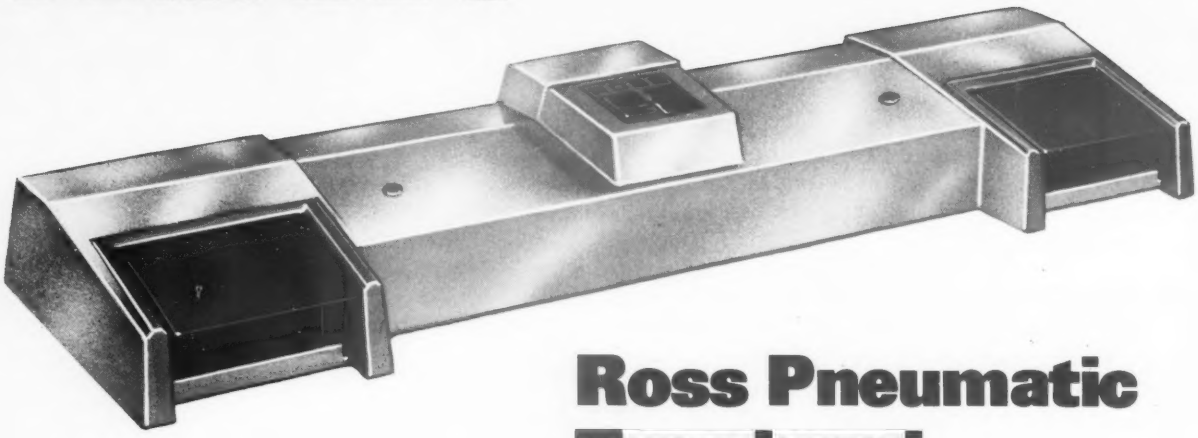

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# EDITORIAL

## THREE CERTAINTIES AMONG THE UNCERTAINTIES

In a year filled with uncertainties, we feel certain about one thing: In this Manufacturing PLANBOOK: 1975 you'll find comments, suggestions, or ideas that can trigger solutions to problems you are working on.

We say this not out of vanity. Rather it is because of what readers said about last year's PLANBOOK, and out of the respect we have for the companies and persons whose successes and thoughts are reported in the following pages.

An independent survey of readers of the 1974 PLANBOOK indicated that 76 percent found such ideas . . . a third are using the Evolution of a Project approach to help in their project management . . . and 51 percent discovered new sources of equipment or other products. Incidentally, through suggestions from readers, the Evolution of a Project worksheet in this issue is revised and, we feel, improved.

There's another thing we are certain of. In every industry, no matter what its economics of the moment are, planning for manufacturing change is continuing. Even in the hardest-hit ones, such as automotive, many projects are committed because of product change, OSHA, or some other "won't wait" reason. In those cases, success may depend on substitution of breakthroughs or radical changes instead of more modest upgrading.

You may find leads to such changes in this issue.

Obviously, it is impossible to generalize on the level of planning activity going on. In some production engineering departments, the ranks have been leaned by layoffs, some projects have been cancelled, and others held up indefinitely. At the same time, however, many companies turning out electronic products, farm machinery, construction equipment, to name three, are going full tilt. Significantly, in this issue we report that 49.4 percent of the metalworking companies we surveyed for their 1975 capital spending plans will *increase* their investments this year.

We subscribe to a philosophy that is saved from becoming trite only by its validity. This is the third certainty. American industry will survive and grow on the basis of its productivity.

Government policies, fiscal, monetary, and other, are important. The mood of the people is important. But our productivity transcends these in importance.

This is fundamentally what *your* planning work is all about. We hope *our* PLANBOOK makes a contribution.

Robert F. Huber

# SUCCESS: FIND A WAY...OR MAKE IT

**The desire to win through to success is key to achieving it. But ambition alone cannot materialize that ephemeral will-of-the-wisp. Ted Pollock boils down the elusive essence of success and helps you measure your own Success Quotient. And he explains how to orient your built-in "magic machine" toward continuing personal growth**

Biographers and researchers make an endless game of trying to narrow down and single out the elements uniquely present in the lives of those who have reached the heady summit of success.

These "what-it-takes-to-be-successful" lists are anything but unanimous. The more closely you examine each requisite, the more exceptions come to mind. One cites "a high degree of self-discipline" as a trait universally shared by the successful. But you need only think of "Diamond Jim" Brady, who would himself have been the last to claim this virtue, or "Bet-A-Million" Gates with his unbridled temper and wild contempt for discipline.

You have to be a hard worker to achieve success? Not even this conventional wisdom necessarily stands up. Immortal Socrates drove poor old Xantippe to pot-throwing fury with his loafing, irresponsible ways. And Alexander Graham Bell was a dreamer who puttered his way into history.

In the attempt to pinpoint the basic building blocks of success, the list grows longer and longer. But, in their boiled-down essence, three ingredients survive all the tests and defy exceptions.

What are they?

1. *Ability.* You have never known a truly successful person who could not do at least one thing considerably better than most people.

2. *Desire to succeed.* People do not really succeed "in spite of" themselves. The men and women who get ahead *want* to.

3. *Intelligence.* Although it is difficult to define, the range of abilities described by this word—from understanding to problem solving—is a *sine qua non* of success. This is not to say that only those blessed with high IQs are destined for the stars. Indeed, we can all cite cases that appear to prove precisely the contrary. But those who succeed are usually those who use their intelligence most fully.

## WHAT YOU CAN DO

If you are old enough to read this, you have undoubtedly already identified the ability that is uniquely yours. No article will alter that.

Nor is anything you read likely to intensify your desire to succeed. Either you want to or you don't.

Certainly, nothing in print is going to increase your native intelligence, which is largely the result of heredity.

Where, then, does all this leave us?

With only one possibility: to find ways to *apply* the intelligence you already possess to the challenges of succeeding in your work. And fortunately, this is not difficult. All it requires is, first, the identification of those areas where improvement can most effectively be made, and, second, specific suggestions on how to make those improvements.

Here, then, are concrete proposals for raising your Success Quotient in the only way possible: through brain power. To be sure, success is not confined to a mastery of these essentials only. But ignoring them will almost surely contribute to failure.

## ORGANIZE YOUR TIME

Think of the man you most admire. Perhaps he is a high ranking government official, a man with awesome responsibilities, one whose decisions affect millions. Possibly, he is the head of a giant corporation, the moving force behind a far-flung industrial empire who must be up-to-date on a hundred different subjects. Maybe he is a world-renowned scientist whose experiments have resulted in a better world for all.

Whoever the man, regardless of his age, economic status or family background, *he hasn't one second more of time at his disposal than you!*

He has merely learned how to *spend* his share of available time to best advantage, to pack every working minute of his life with meaningful accomplishment.

If you knew what he knows—the proper way to start a project, how *not* to dissipate your energy, how to find extra time for extra achievement—your chances for success would be vastly enhanced.

Some tips:

**Pinpoint your goal.** A lot of people waste time and energy on a job simply because they lack a clear idea

of what they want—or are supposed—to do. Unable to see where they are going, they make false starts, lose their way, get discouraged, turn in performances unworthy of them.

Know your destination from the beginning, though, and you'll get there a lot faster.

Ask yourself, therefore, "What, precisely, do I want to accomplish?" Once you know the answer, you can marshal resources, plan your strategy, identify people who can help you. So whatever it is you must do, get it clear in your own mind. That's crucial.

**Tune out "emotional static."** Most of us tend to overlook the emotional time-wasters in our lives. Here are the main culprits, along with suggestions for effectively combatting them.

(a) *Frustration.* If you want to burn up your energy three or four times faster than normal and dull your enthusiasm completely, be frustrated. But if you want relatively smooth sailing on the job, then treat frustration as a normal development in your life. Expect a quota of such problems and tackle them as you would any other problem. Analyze them, study them and, if necessary, sidestep them for the moment and turn your attention to something more promising until there is a better time to do the job.

(b) *Irritation.* Here is an energy sapper that can be destroyed simply by putting it into proper perspective. Analyze the cause. Is it worth the energy you're expending?

(c) *Impatience.* Fret about the time you're losing while waiting for a report, a telephone call or a visitor and you burn up a lot of energy unprofitably. But put the same energy to work on some project or plan and, presto! you turn waiting time into productive time.

(d) *Worry.* Largely the result of mentally turning "might happen" into "will happen," worry is a senseless drain on your energy since the chances are roughly fifty to one against the unpleasant eventuality occurring. Even if it does, why not consume the energy once instead of doubling that consumption by worrying in advance?

As a general antidote, try *action.* This doesn't only give mental relief; it stimulates your resourcefulness and opens up new and perhaps unexpected paths. As a final thought, so-called trouble frequently turns out to be a blessing in disguise. So why worry?

**Get a jump on tomorrow.** One of the biggest stumbling blocks to individual achievement: the all-too-human tendency to postpone a job. To avoid this wasteful procrastination, use reverse strategy—*start tomorrow's task today.* In the morning, you will get a psychological lift from finding the task already begun, be better prepared to plunge right in and finish it.

In reality, you will be taking advantage of a well known psychological fact: our memory for uncompleted tasks, sparked by the unresolved tensions they create, is ten times greater than our memory for completed or unstarted ones. When you leave a job unfinished, your subconscious—that silent ally always on duty—goes to work on it. Later, when you return to the job, you are often amazed to discover that you have a whole new arsenal of ideas, insights and solutions from which to draw.

**Learn from mistakes.** At the end of each day, some executives use pencil and paper to plan the next day's activities. But the vice president of a New York brokerage firm goes one step further: He writes down all the ways in which he's wasted time. He says this approach keeps him from repeating his mistakes and reports that it's increased his efficiency at least 50 percent.

## DEVELOP ENTHUSIASM

The late Frederick Williamson, president of the New York Central Railway, was once asked what he thought success in business hinged on. This is what he answered:

"The longer I live, the more certain I am that enthusiasm is the little-recognized secret of success. The difference in actual skill, ability and intelligence, between those who succeed and those who fail, is usually neither wide nor striking. But if two men are nearly equally matched, the man who is enthusiastic will find the scales tipped in his favor. And a man of second-rate ability *with enthusiasm* will often outstrip one of first-rate ability *without enthusiasm.*

"Enthusiasm means believing in your work and loving it, be it digging a ditch or directing a great company. To an enthusiastic man, his work is always part play, no matter how hard or demanding it is. If a man is in this frame of mind, he is bound for the stars and success."

If you ever find your own enthusiasm for your work waning, try these tested antidotes:

**Learn all you can about how your job fits into the "big picture."** Many people feel like unimportant cogs in a giant machine because they don't understand, or have forgotten, the ramifications of their jobs. A riveter in an airplane factory helps keep his

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**Associate with enthusiastic people.** Just as it is practically impossible to be an optimist among pessimists, so it is impossible to be enthusiastic amidst people who drag their feet and their minds around the dull routine of daily duties. But mix with men and women who are excited about their work, interested in the world and its future—and some of their enthusiasm is bound to rub off.

**Act enthusiastic.** Almost a century ago, Psychologist William James advanced a startling theory: He said that emotional experience is simply the perception of bodily changes. People had always thought, for example, that 1) you meet a bear, 2) you are frightened, 3) you run. James said this was wrong; the correct sequence is 1) you meet a bear, 2) you run, 3) you are frightened. In other words, *you don't run because you are afraid; you are afraid because you run.*

To support his theory, now widely accepted, James argued that unless you assumed the posture typical of an emotion, you could not experience that emotion. For example, if a situation calls for grief and instead of slumping you hold your head high and stick out your chest, far less grief will come. On the other hand, if you assume the posture typical of a certain emotion, you will tend to have that emotion.

The moral for those seeking to generate enthusiasm? Tackle your job with zest, with an "I'm-going-to-enjoy-this" attitude and you will be enthusiastic!

## LOOK FOR TROUBLE

No business is so problem-free that it can't benefit from a careful scrutiny of its methods. Consider the areas in which problems can occur: underproductivity, materials shortages, high prices, delivery snafus, astronomical interest rates, lots more. In your very own department, on your very own job, things are probably not as perfect as they might be.

And if you think they are—look again. Raise your sights. Refuse to be satisfied with Things-As-They-Are. Search for better ways. Ask yourself questions like: "What can be done more efficiently?" "How is money being wasted?" "Where can steps be saved?" "Is there unnecessary duplication of effort?" "Is there a better sequence for performing this job?" "What can be eliminated . . . combined . . . simplified . . . standardized?" Cultivate the habit of "constructive dissatisfaction" with your job—not for purposes of griping, but for improving results. In short, look for trouble. It pays.

## FIND SOLUTIONS

Sometimes, spotting trouble is a big contribution in itself. But you can add substantially to your chances for recognition and advancement by also searching for remedies.

Where do the answers to problems come from? Just about everywhere. They come from experience, experiments, accidents, daydreams, contacts and hard work. You never can tell where or when you'll find them. But there are ways to coax them into existence.

### Success In The 1980s

Because corporations will be increasingly subject to public scrutiny by consumerists, government bodies and stockholder activists, future corporate executives will probably operate in a society where "making a profit" is no longer the sole rationale for business activity. As a result, predicts Dow Votaw, professor of business administration at the University of California, "corporate antennae" will have to become sensitive to "frequencies other than the economic."

Some additional predictions:

- The "narrow specialist" will have difficulty moving up the executive ladder in the years ahead, says Louis D. Volpp, dean of the Columbia University Graduate School of Business. But the man with a broad perspective and "integrative skills" will be in great demand.
- Executives will tend to change employers more frequently, as they seek a greater sense of achievement and new challenges from their work. "Loyalty to the organization is going to be less of a deterrent to job switching in the future, especially if pensions become portable," says John McArthur, director of the Canadian Management Center.
- The growing importance of international trade and investment will gradually limit the "promotability" of those not equipped to think in global terms.
- Most executive recruiters foresee a rosy job market for men and women with a strong background in finance, data processing, law and industrial marketing.
- There will be a growing demand for women and minority executives as companies step up Affirmative Action programs.

Next time you're looking for a solution to a problem, try some of these approaches:

**Use your imagination.** Fresh ideas have two major enemies: logic and common sense. Most of the world's great inventions were fathered by men with the ability to conduct their minds on free-wheeling adventures into the non-existent, the unconventional, the absurd. Try it yourself on the very next problem you unearth. How would a child solve it? Would more of something help? Less? How about using something else? Something lighter? Something heavier? Something smaller? Something bigger? Can you solve this in some combination? With

what? With whom? Don't be afraid of getting wrong answers. You only need one correct one.

**Draw on past experience.** In searching for solutions, we often ignore the obvious. Yet, what is right in front of our noses may be just what we are looking for.

As a mature person, you have a vast reservoir of personal experience to draw from. You have faced dilemmas before and, in one way or another, have solved them. To get the maximum benefits from a review of your own experience, try these "trigger questions":

1. Have I ever had to make a similar decision?
2. How did I go about it?
3. Was the decision reached an effective one? Why?
4. If it was a poor decision, what can I do to avoid repeating that mistake this time?
5. Who, if anyone, helped me make the decision before?
6. Can I call upon him again?
7. In view of the results of my previous decision, can I reasonably anticipate reaching a wise decision now?
8. How, precisely, does the present situation differ from the past one?
9. In view of these differences, what modifications should I make in my thinking?
10. Has the passage of time altered in any way the results I may expect from following my own precedent?

**Get it down on paper.** Your pencil can be a helpful tool, too. Write out the problem as simply as you can. Study it. Jot down all the alternatives that occur to you. If possible, draw pictures. Doodle. The mere act of *playing* with a problem frequently yields the solution.

**Brainstorm.** Because ideas tend to generate more ideas, a noteworthy method of finding solutions is to talk a problem over with others: friends, colleagues, relatives. Encourage them to give free rein to their imaginations and share their insights and inspirations, no matter how outlandish they may seem. Something that A says may trigger B who in turn may inspire C and so on. Many ingenious ideas have been born through this kind of "free association."

## ACQUIRE ADDITIONAL SKILLS

Specialist or generalist—who has the better chance of getting ahead? The debate is almost as old as business itself, but recently—with the dramatic shrinkage of opportunity in many fields as an out-of-whack economy tries to pull itself together—the question has been raised with a new sense of urgency. The consensus: The economic environment of the mid-1970s will bring a continued demand for strong general management executives, while cost-consciousness and manufacturing problems will spur demand for technical executives.

There will, apparently, be room for both the specialist and the generalist, then, with the latter having an edge in reaching the very top posts in a company.

Perhaps one management consultant sums it up best with this observation: "The major requirement a decade ago was for managers with specific knowledge and experience in a particular industry. Now the pendulum has swung toward a desire for the broad skills of administration, such as planning, organizing and controlling."

Whichever path you choose, you can only add to your value and potential by adding to your knowledge. If, for example, you are an engineer, clearly the more you know about such non-engineering disciplines as finance, trade, government regulations in your industry and so on, the better your chances for recognition and advancement. Possible avenues to new knowledge include university level evening classes, company-run education programs, a disciplined home reading program, mingling with those in other areas, association-conducted symposia and the like.

**Are You Success Oriented?**

Success almost never falls in your lap. You have to pursue it—actively, aggressively, continually. Do you? Your answers to the following questions will give you an idea.

1. Are you thirsty for success? That is, do you yearn for its outer trappings—affluence, power, fame?
2. Are you competitive by nature?
3. Do you believe that your personal work standards are higher than those of your colleagues?
4. Did your parents exert pressure on you to excel in school?
5. Do you frequently find yourself comparing yourself with your peers?
6. Does your spouse encourage you to work hard, put personal considerations aside in favor of company matters, "beat" the competition?
7. Do you have a personal success timetable? If so, are you on schedule?
8. Do you tend to identify more with management than with employees?
9. Do you go out of your way to impress your immediate superior?
10. Do you have a reputation as an ambitious person?
11. Do you have a strong self-image? That is, do you see yourself as possessing the traits normally associated with business success?
12. Do you believe that you can do your boss' job better than he now does it himself?
13. Do you ever catch yourself worrying about the impression you are making on your boss?

If you answered 10 or more of these questions in the affirmative, you have the personality of a success-oriented person.

**Good Reading**

There are hundreds, perhaps thousands, of books in print today that, in one way or another, deal with achieving on-the-job success. Any selected bibliography necessarily reflects the selector's prejudices. With that clearly understood, here are some titles that I think especially worthwhile.

- Peter F. Drucker, *Management*, Harper and Row, 1973.
- Rudolf Flesch, *The Art of Clear Thinking*, Harper and Brothers, 1951.
- Benjamin Franklin, *Autobiography*, many editions.
- Edward Hodnett, *The Art of Problem Solving*, Harper and Brothers, 1955.
- Alan Lakein, *How To Get Control of Your Time and Your Life*, Peter H. Wyden, Inc., 1973.
- A. H. Maslow, *Motivation and Personality*, Harper and Row, 1954.
- Douglas McGregor, *The Human Side of Enterprise*, McGraw-Hill, 1958.
- Ralph G. Nichols and L. A. Stevens, *Are You Listening?* McGraw-Hill, 1957.
- Alex F. Osborn, *Applied Imagination*, Charles Scribner's Sons, 1958.
- Lionel Ruby, *The Art of Making Sense*, J. B. Lippincott Company, 1954.
- F. W. Taylor, *Scientific Management*, Harper's 1912 and many editions.

## SEEK OUT RESPONSIBILITY

The average reaction to a new assignment is—"Why me?" Fear of failure temporarily paralyzes initiative; self-doubt sets in.

But why be average?

Seek out responsibility and you immediately do three things: You announce your self-confidence; you create an opportunity to show what you've got; and by taking the initiative, you eliminate 90 percent of your "competition"—the timid ones—right off the bat.

If you look around for something to do when your immediate assignment is fulfilled, if you stay with a job when others would let down, if you're willing to show someone else how to do something, you're the responsible kind who's likely to get noticed. If, on the other hand, you work *only* upon instructions and under supervision, turn over a new leaf. Immediately.

## KEEP GROWING

Those who reach the top are invariably men and women of wide-ranging interests and accomplishments; they are as much at home amid a group of university trustees as at an industrial conference.

The key to their success is continual personal growth. And the secret of such growth is being interested in things and people.

You know how it is with a child. Everything he sees is transformed into a question: "What's that?" "How does this work?" "Why are you doing such-and-such?" A child's world is a world of wonder which stirs his curiosity and captures his interest. Because he is interested, he is fascinated and alive. This is also the mark of a growing adult.

You can keep your own personality alive and flourishing by creating for yourself a concrete plan to improve your mind and then working at it. Begin with a subject that interests you. It may be the internal combustion engine or the philosophy of Confucius; the ice cap at the North Pole or the life of Augustus Caesar; the effect of space travel on the central nervous system or the economy of early Mayan civilization. The subject may be incidental to—or entirely divorced from—your business; the important thing is that you come to life when you get into it.

Then set aside a definite time each day to read and study it. Let nothing interfere with this. Do this regularly for a few weeks and you will soon not allow anything to stand in the way of it, for the deeper you delve, the more interested you will become. You will find yourself asking questions and seeking answers. You will discover that your subject inevitably leads to many other subjects. In the process, your horizons will expand and you will experience the pleasure of growing mentally. Others will doubtlessly recognize a new vitality in you. And you will develop into a person more worth knowing than ever.

## YOUR MAGIC MACHINE

Suppose a total stranger approached you with this proposition:

"Sir, I offer you a machine that can guarantee you success. Light, portable, requiring no electricity or battery, it will gather all the facts you want on any given subject, weigh the evidence and arrive at a sound decision. Properly maintained, it will investigate anything you wish, keep a permanent record of every bit of information it collects, tote up figures, provide profitable insights and render precise judgments. It will enlarge your vocabulary, teach you anything you want to know and warn you of impending dangers. With it, you can win the admiration of your fellows, predict the future with an astonishing degree of accuracy and avoid many of the pitfalls of life. It will enable you to sit at the feet of wise men long dead, communicate with those you cannot see and learn from the mistakes of others. It weighs three pounds, will last a lifetime and it's free!"

Would you accept?

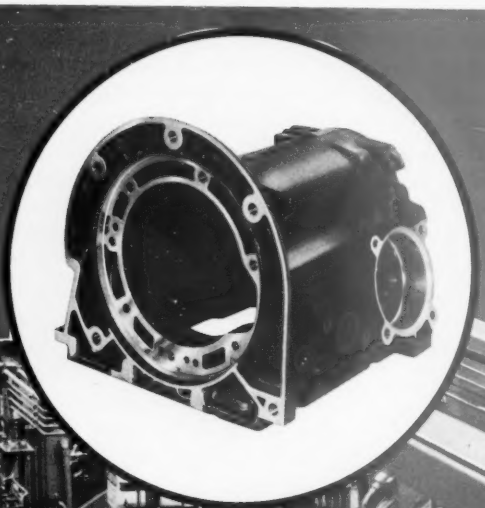
Probably not, for your first reaction would be, *there must be a catch somewhere.*

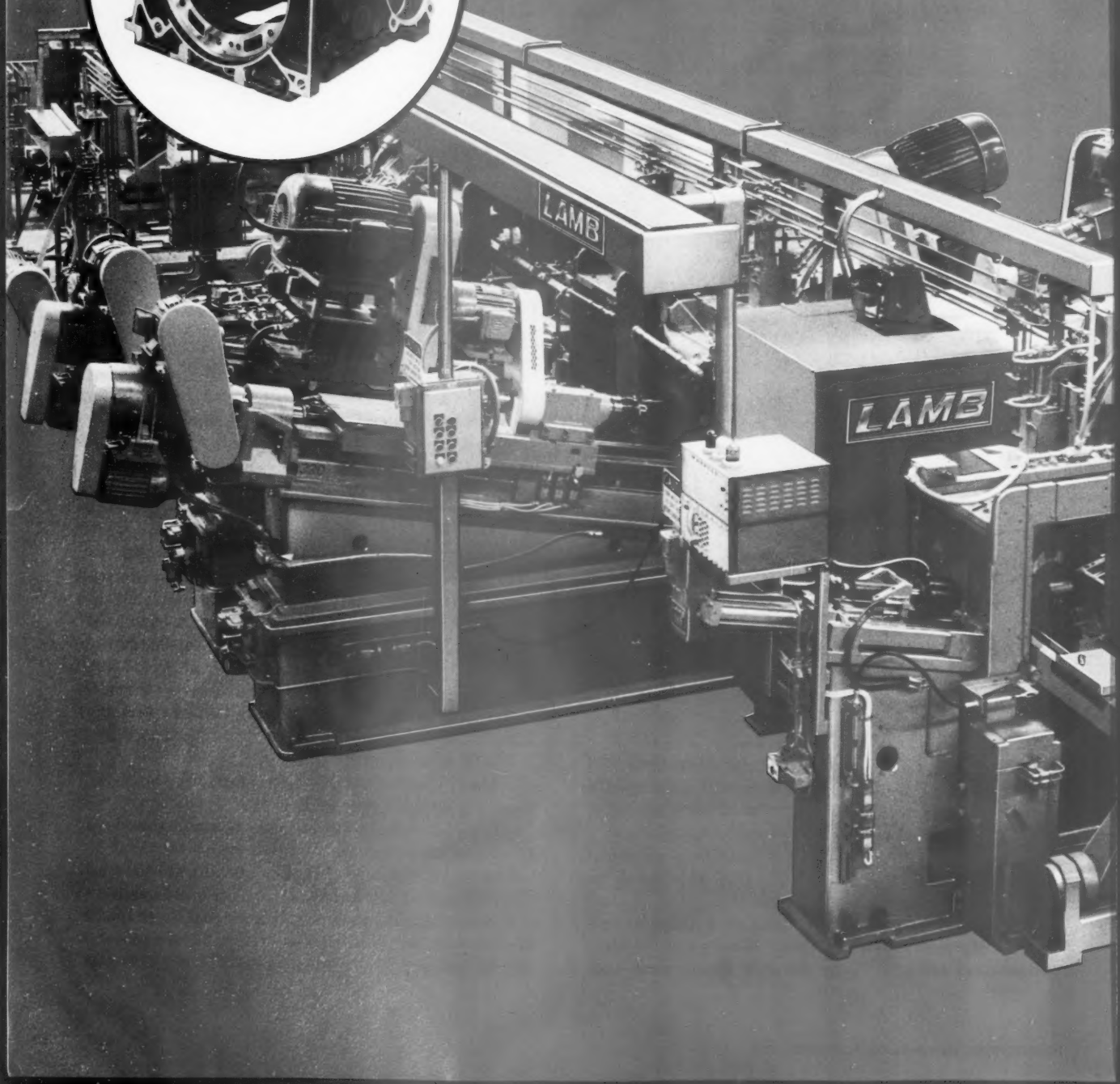
Yet, this startling proposition is, in a sense, made to all of us at the moment we are born.

The magic machine, of course, is your brain. And there is indeed one small catch: You must use it.

But any thinking person will agree that, in an era of double-digit inflation, this is small enough a price to pay for success. ■

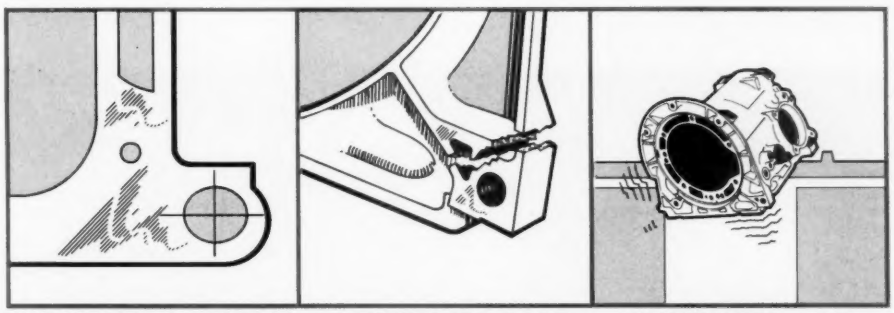
# CYCLOIDAL MECHANICAL DRIVE





# means TRANSFER ACCURACY

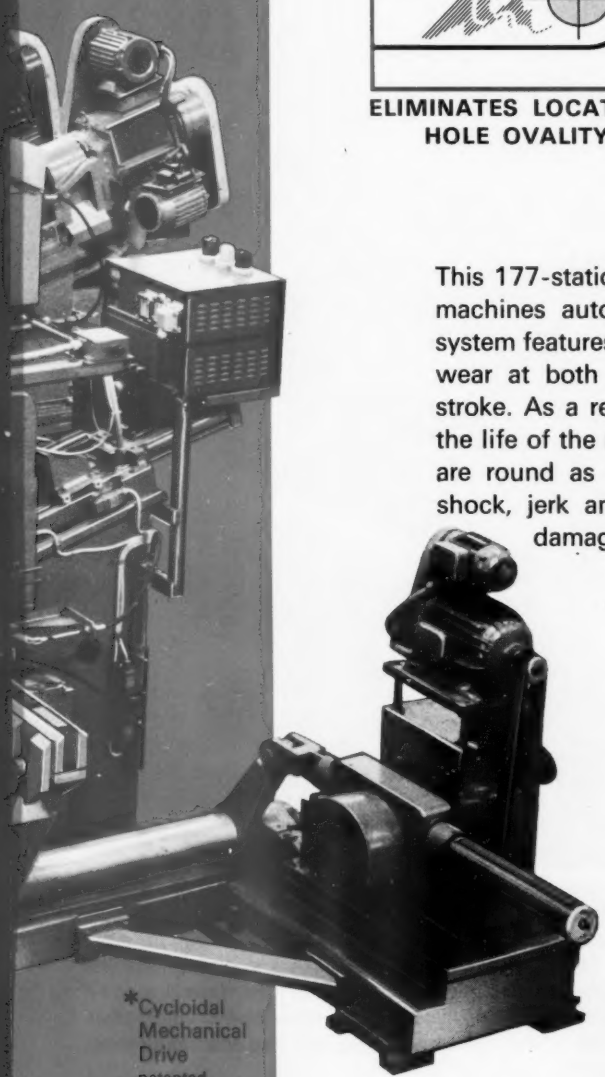
## *Elimination of shock, jerk and bounce insures quality transmission cases*



ELIMINATES LOCATING HOLE OVALITY

ELIMINATES PART BREAKAGE

ELIMINATES LOSS OF CONTROL



*Cycloidal Mechanical Drive patented

This 177-station, 640-foot long LAMB transfer line completely machines automotive transmission cases. The patented drive system features Cycloidal Mechanical Motion*, which eliminates wear at both beginning and end of the high-speed transfer stroke. As a result, locating accuracy is maintained throughout the life of the machine, tolerances are held accurately and holes are round as they should be. In addition, the elimination of shock, jerk and bounce puts an end to loss of control and damage to the part.

*Cycloidal Mechanical Motion—smooth change in acceleration with almost zero change during first and last five degrees of movement. This may be contrasted with Harmonic Mechanical Motion, which has abrupt acceleration peaks at the beginning and end of movement, creating extreme jerk and shock.

LAMB

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DETROIT, MICHIGAN 48234

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Special Machines and Automation Equipment

**INDICATE NO. 207 ON BUSINESS REPLY CARD**

# They Save Money!

## Steels that help you put an end to wrinkling in drawing parts like this We call them . . .

*Bathroom cabinet manufacturers often run into excessive die maintenance when corners of blanks wrinkle during drawing, the wrinkling becoming embedded in the dies. Kent Corporation, Bellevue, Kentucky, reports that grinding a die and then breaking it in can cost $400 to $500. Using Armco I-F steel, the firm estimates that dies last four times as long between redressings. Perhaps Armco I-F steels can help you reduce fabrication costs. They are available in cold-rolled, hot-rolled,* ZINCGRIP, *long ternes, and enameling steel.*

# Armco I-F Steels

Armco I-F steels do draw better. In fact, they have proved the most significant breakthrough in drawability since the development of aluminum-killed steels, also an innovation from Armco Research and Technology.

Of course, we can't offer you a specific level of results, but case after case indicates that I-F steels outdraw rimmed and aluminum-killed steels. In a typical example, a drawn part with a 5% breakage rate was reduced to zero rejects on a 10,000-part run when switched to Armco I-F steel. I-F steels also show better resistance to wrinkling and tearing during difficult draws. Because they are nonaging and nonfluting, there are no stretcher strains to mar their surface.

**Now there are five**

Armco I-F steels are now available in cold-rolled, hot-rolled, ZINCGRIP, long ternes, and enameling steel.

For complete information on any of these superior drawing quality steels, use the reply card or write Armco Steel Corporation, Dept. E-35, Box 600, Middletown, Ohio 45043.

Armco, the Armco Triangle, I-F and ZINCGRIP ® trademarks of Armco Steel Corporation, Middletown, Ohio

ARMCO

# How to Sell a Project

**"At least one in 10 of all proposals submitted and rejected probably should be reconsidered and more evidence gathered. Most of these represent a basic need we have, but the case is not made."**

That statement made to the PLANBOOK by a company manager is, in his opinion, probably conservative.

How do you "sell" a project? Not with chicanery, unless you're planning to change jobs anyway. Not with some sharp manipulating of the figures; you're the one who will then have to manipulate a success when you have to make the project work as well as your pencil did.

No. It seems that some projects are lost to the stringent requirements of today's dollar ROI requirements because the proposals fall short of taking advantage of the full justification due them.

**Help!** "If it looks as though I'll get a payback period of more than six months, I don't even submit the proposal."

Thus, only somewhat whimsically, one process engineer talked to the PLANBOOK about the tight money problem as it has affected his company's willingness to spend.

Another production engineer at a different company says: "We are continuing to work on programs for new products coming up. And where product quality has a warranty- or liability-implication, we can push through new equipment or process proposals. But straight replacement of equipment for cost reduction is almost impossible to justify today."

In fact, productivity gains—the objectives of countless clarion calls from a beleaguered economy—are almost universally tough to justify on a one-year payback or an 80 to 100 percent first-year return on investment.

So, what can you do about the ROI that isn't there? What can you do to make a sale out of what otherwise looks like a sure loser?

**Inventory.** In almost any calculation of benefits from an investment, the project engineers go through an evaluation of whether or not inventory will be reduced . . . in-process, raw materials, components, or finished product.

A Westinghouse Electric Corp. plant at Charlotte, N.C., is full of numerically controlled machine tools, radio-controlled cranes, computer-directed record systems. A sister plant with older, more conventional equipment and about the same product mix normally requires about 35 per cent more inventory than the Charlotte plant.

At an automotive parts plant near Detroit, powdered metal components, small parts that go in multiples on each car, were being purchased from an outside source. At full-tilt production, the requirement was 60,000 such parts a day. Although the supplier's plant was less than 50 miles away, an inventory of about four days worth of parts was deemed necessary to allow for any delivery breakdowns. That's 240,000 parts.

Desiring to get the operation in-house, manufacturing engineers worked out a way to form the parts on a cold header, and now, because full control of the header and the tooling is at the plant, only a two-shift inventory is needed.

Doubtless most company's engineers could cite similar inventory "savings." The ROI opportunity here is that the potential inventory reductions are *not* normal savings; they should not have to be put into your justification like direct labor and floor space.

Westinghouse has a corporate policy that dictates that inventory reductions be treated as capital savings, and that they be deducted directly from the gross price of the equipment. More and more companies are using the same technique. If your management has not yet adopted the practice, try to sell them on it. (If need be, write to the editor, PLANBOOK, Box 101, Bloomfield Hills, Mich. 48013, for more supporting information.)

This approach alone can make the difference on some projects. And the logic is quite simple.

Look at the company balance sheet. On the asset side, some of the owners' dollars are tied up in inventory, and today it's costing the company more than 12 percent to keep that money there. Up above on the list is plant and equipment (in some companies the two figures are closer than most suspect). Those dollars are earning money for the company every day.

PRODUCTION's

Evolution of a Project

Evolution of a Project

Evolution of a Project

Evolution of a Project

For a step-by-step route from an idea to the production accomplishment, see inside

**PRODUCTION's**

# Evolution of a Project

## Stage 1

### Basic Objective

1 ☐ Add capacity

2 ☐ Cost reduction or profit improvement

3 ☐ Redesign or new product

4 ☐ Product improvement

5 ☐ Replacement of inadequate equipment, tools, or materials

6 ☐ Plant or process modernization

7 ☐ New plant

8 ☐ Energy conservation

9 ☐ OSHA conformance

10 ☐ EPA conformance

11 ☐ Metrication

12 ☐ Other: _____

Date: _____

Project No. _____

Description _____

## Stage 2

### Steps to Solutions

*Check actions that will be necessary*

1 ☐ Production cost analysis

2 ☐ Parts or process quality analysis

3 ☐ Plant or dept. capacity analysis

4 ☐ Process or methods comparisons

5 ☐ Product design review

6 ☐ Materials evaluation

7 ☐ Make vs. buy review

8 ☐ Plant services review

9 ☐ Manpower review

## Stage 3

### Evaluating Approaches

PLANT CAPACITY STUDIES
1 ☐ Add floor space
2 ☐ Add work shift
3 ☐ Increase process output
4 ☐ Build new plant
5 ☐ Add more people
6 ☐ Add more overtime
7 ☐ Increase efficiency of floor space
8 ☐ Other: _____

PROCESS OR METHODS COMPARISONS
1 ☐ Change process or method
2 ☐ Modify present process or method
3 ☐ Add more of same units
4 ☐ Replace units with same
5 ☐ Other: _____

PRODUCT DESIGN REVIEW
1 ☐ Change tolerances
2 ☐ Alter configuration
3 ☐ Change structure
4 ☐ Change component
5 ☐ Other: _____

MATERIALS EVALUATION
1 ☐ Change alloy
2 ☐ Change kind of material
3 ☐ Alter shape or size
4 ☐ Alter condition of material
5 ☐ Change vendor
6 ☐ Other: _____

MAKE VS. BUY REVIEW
1 ☐ Make new parts
2 ☐ Make more parts
3 ☐ Make less parts
4 ☐ Buy new parts
5 ☐ Buy more parts
6 ☐ Buy less parts
7 ☐ Change vendor
8 ☐ Other: _____

PLANT SERVICES REVIEW
1 ☐ Check supplies of air, power, gas, etc.
2 ☐ Check available floor space
3 ☐ Is material handling adequate?
4 ☐ Are toolroom facilities adequate?
5 ☐ Is maintenance force current with technology?
6 ☐ Other. _____

MANPOWER CONSIDERATIONS
1 ☐ Number of people needed (by skills)
2 ☐ Supervisory force competence
3 ☐ Additional training requirements
4 ☐ Organization structure

## Stage 4

### The "Justifying"

*If you are going to a new process or new equipment, note the impact of any of the following on your proposed change. Then, wherever possible, estimate the dollar gain or cost of the factor. Use the total to help justify your proposed action, and to compare it with the present or alternative methods.*

1 ☐ Inventory*
2 ☐ Direct labor**
3 ☐ Indirect labor**
4 ☐ Fringe benefits**
5 ☐ Tooling (including new tools for greater productivity)
6 ☐ Maintenance (including where necessary training for new equipment)
7 ☐ Supplies (compressed air, lubricants, coolants, welding wire, etc.)
8 ☐ Floor space (plus air space over the equipment)
9 ☐ Power (electricity, gas, etc.)
10 ☐ Downtime (anticipated maintenance plus tool change and adjust, inspection, etc.)
11 ☐ Scrap and rework (including cost of handling scrap)
12 ☐ Taxes, insurance and depreciation
13 ☐ Subcontracting
14 ☐ Lease vs. buy
15 ☐ Equipment flexibility (for product mix or future design change)
16 ☐ Material handling
17 ☐ Materials costs
18 ☐ Elimination of assembly or other secondary operations
19 ☐ Availability of equipment service
20 ☐ Availability of replacement parts
21 ☐ Equipment standardization
22 ☐ Enhanced product value
23 ☐ Lead time
24 ☐ Attitudes of supervision and operators (productivity, absenteeism, etc.)
25 ☐ Effect of project on other operations
26 ☐ Warranty costs
27 ☐ Field product service costs
28 ☐ OSHA conformance (safety, noise, illumination, etc.)
29 ☐ EPA requirements (air, water pollution, waste disposal, etc.)
30 ☐ Metrication
31 ☐ Other equipment needed (cranes, elevators, lift trucks, etc.)
32 ☐ Salvage value
33 ☐ Other: _____

*Inventory is not a cost. It is a capital asset and can be subtracted directly from the cost of the project.
See PRODUCTION, July, 1971, page 53.

**All labor costs should include projections for known or anticipated increases during the payback period.

## Stage

### Listing

*Based o*
*use the*
*includin*
*foundat*
*equipme*
*to calcu*
*or payb*
*If the R*
*meet yo*
*then pre*
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on
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ar
5 ☐ Oth

Date(s)

## Stage 5

### Listing the Alternatives

*Based on your work to this point, use the total installed cost, including the price of the equipment, foundation, pit, basement, ancillary equipment, startup costs, etc., to calculate a Return on Investment or payback period. If the ROI or payback period meet your company's requirement, then prepare a proposal for approval and funding. After authorization:*

*Request Bids or Prices for a Specific Type of Product*
1 ☐ List acceptable sources
2 ☐ Suggest acceptable alternate sources
3 ☐ Other: _____

*Request Proposals for a Specific Job or Project*
1 ☐ List acceptable sources
2 ☐ Suggest acceptable alternate sources
3 ☐ Other: _____

*Visit Vendor Plants*
1 ☐ List plants to be visited
2 ☐ Suggest acceptable additions
3 ☐ Other: _____

*Discuss with Supervision, Maintenance, Operators*
1 ☐ Explain new concept and benefits
2 ☐ Discuss training and skills needed
3 ☐ Show impact (if any) on status quo
4 ☐ Make sure efficiency estimates are right
5 ☐ Other: _____

Date(s): _____

## Stage 6

### Project Proposal

1 ☐ Evaluate bids or alternatives

2 ☐ Select vendor(s)

3 ☐ Propose purchase

4 ☐ Other: _____

Date(s): _____

## Stage 7

### Purchase Procedure

1 ☐ Appropriation request

2 ☐ Approve purchase and

3 ☐ Issue purchase order

4 ☐ Supplier contact

5 ☐ Prepare floor space

6 ☐ Train personnel

7 ☐ Notify production of increased capacity

8 ☐ If standards change, notify proper depts.

9 ☐ Check status of tooling, supplies, etc.

Date(s): _____

## Stage 8

### Into Production

1 ☐ Promised delivery

2 ☐ Follow Up

3 ☐ Installation complete

4 ☐ Accepted for production

_____

Acceptance Date(s):

_____

## Stage 9

### Post Audit(s)

1 ☐ Is it producing as anticipated?

2 ☐ Is quantity adequate?

3 ☐ Is quality adequate?

4 ☐ Are costs in line?

5 ☐ Other:

6 ☐ Corrective action required

_____

_____

Corrections made, or performance verified.

Date: _____

The Evolution of a Project above is meant to be a guide to help you in your management of change in your company or plant. No single plan will work for all; alter it and tailor it to best meet your needs. Also, notice the Project Status Report on the next page.

If you can suggest ways to improve them and make them more useful, please send your ideas to:
Editor: PRODUCTION, Box 101, Bloomfield Hills, Mich. 48013

If you'd like to use the above outline for planning, you can get 10 worksheets for $1.00 by writing to PRODUCTION.

Copyright 1975: Bramson Publishing Co.

Date _____

# PROJECT STATUS REPORT

Project Title _____ Dept. In Charge _____ Route to: _____

Project No. _____ Project Supervisor _____

Anticipated Cost _____ Anticipated Savings _____ Payback _____

| | Time Periods* |
|---|---|
| Stage 1 Basic Objectives | |
| Stage 2 Steps to Solutions | |
| Stage 3 Evaluating Approaches | |
| Stage 4 The Justifying | |
| Stage 5 Listing the Alternatives | |
| Stage 6 Project Proposal | |
| Stage 7 Purchase Procedure | |
| Stage 8 Into Production | |
| Stage 9 Post Audit(s) | |

*Can be "Week 1, 2, 3," etc. Or "Week of Mar. 17, Mar. 24," etc.
Time period statements can be any that best suit your own practices.

If you can move dollars up from inventory and put them in capital equipment, you have made a substantial contribution to profits. And you may turn a tough proposal into a success.

**Pick the Winners.** That's easy for us to say. But it means more than just looking for the obvious weaknesses in manufacturing, where a new method might look spectacular. (Don't overlook them, either.) But take the case of an air-conditioner manufacturer. Three years ago, he had a program to automate assembly. The system had been engineered and worked out, but the payback period was longer than the anticipated product life.

So his engineers went back into the program. First, on the automated testing, justifying it with a manpower reduction, reduced rejects and rework, and lower field warranty and service costs. The project sold.

Next, they automated six inspection stations for checking of subassemblies. This reduced manpower and simplified the testing that had to be done at the end of the line; this also improved field repair costs.

Since that time, they have picked four other assembly segments and have been able to justify the automation of them. It's questionable whether the total system they originally envisioned will ever exist in the plant. But they keep chipping away at those portions that can be justified.

In another case, the manufacturer of small compressors saw his chance for automatic assembly. Three vendor quotes convinced him he'd never make it a go economically. Then, as in the prior case, he picked those operations that could be justified for automation and left the others manual. He now is running a nonsynchronous line with a 40 percent reduction in direct labor and a 20 percent reduction in inspection costs.

Finally, consider the case of the redesign of an air compressor at the Heavy Vehicle Systems Group, Bendix Corp., Detroit. (PRODUCTION, May 1974, p. 92.) The redesign began in 1967 at the Elyria, O., plant. Objectives: A smaller, lighter, more standard, and lower-cost compressor . . . with no sacrifice in quality or performance.

The initial redesign met all objectives, but the capital investment in equipment was exorbitant, and the design was tabled, along with the equipment proposal.

On the second redesign, begun in 1972, production and product engineers took another look at: buy versus make (purchased forged steel crankshafts and cast iron would cut capital equipment requirements by a couple of million dollars), and researching the most economical manufacturing processes on the components. Floor space was saved. Furthermore, standardizing on three crankcases used with seven adapters permits the manufacturing of 103 versions of the air compressor. "The volume increase for the consolidated product line made financial justification of the transfer machine easy," the project engineer says.

Such cooperative work between manufacturing or production engineers and product designers often can turn out the optimum in manufacturing flexibility and result in one proposal that will "sell" instead of several, none of which will fly on its own.

Even in the automotive industry (normally regarded as totally automated, totally inflexible) the "family-of-parts" concept is taking hold. A "family" of engine blocks coming off the same line may well be commonplace in a decade.

**Miscellany.** To many production engineers, the tips and examples above will be reminders of what they already know. The checklist on the adjacent "Evolution of a Project" worksheet is meant to be another reminder of the things most readers know about but may forget. (An independent study of the 1974 edition of the worksheet showed that 32 percent of the readers had, in one way or another, adopted the Evolution of a Project into their planning procedures. The new worksheet incorporates improvements suggested by some of the readers.)

No list of tips on "how to sell" can be complete. But they can include such suggestions as: Know what the first year's volume requirements are, what the long-term sales objectives are, and what the volume should be two, three or four years hence. Where it's a factor, know what the product's market price must be to be competitive, what the profit margin must be, and, thus what its cost must be now and for the rest of its life.

One company admonishes its engineers to know the planned level of output versus capacity, the problems to be expected during the reach for capacity, and the solutions to each. Furthermore, at that company, management wants process and product engineering to anticipate design changes (working with marketing) and to explain how such changes can be accommodated.

When such care in researching each proposal is made, the results may be similar to that expressed by one automotive process engineer: "There's no way I can sell a project. But if we're selective enough, and good enough, and thorough enough, we can submit our quota of projects that will sell themselves." ■

1
MICRO SWITCH
SAME POLARITY
LISTED
LIMIT SWITCH
2
AUTO
MANUAL
3
6
4
5
22SM22-T
7
OFF
OPEN
CLOSE
START
8
TURN TO
START
PUSH TO
STOP
AUTH
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NO TAX
1 2 3
4 5 6
7 8 9
QTY
CHARGE
CHECK
CASH
9

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INDICATE NO. 209 ON BUSINESS REPLY CARD

# COST REDUCTION—
# Your No. 1 Capital Spending Objective

**With operations at a lower level, the metalworking industries shift capital investment goals and look for quicker payback. Spending, while down 25 percent from 1974's level, will approximate that for 1973—a respectable $4.3 billion. Assembly equipment rises to second place behind metalcutting machines**

Capital spending. . . .down, but not out!

Half the responding plants expect to increase spending over their 1974 levels.

The production metalworking industries* are projecting an investment of $4.270 billion in 1975, down 24.8 percent from 1974 spending plans, but approximating the spending level in 1973.

These figures are obtained from the survey conducted annually by Bramson Publishing Co.'s Research Division for use in PRODUCTION and the Manufacturing PLANBOOK.

The 1975 figure as in previous years was projected from the responses from 8000 plants contacted in the survey in October 1974. Although some of the respondents answered the survey prior to the mid-November automotive industry slow-down, the easing of capacity requirements, manpower, and material shortages already was obvious.

**Key Spending Reasons.** While the operating rate of the typical plant responding to the survey fell from 84.1 percent in the fall of 1973 to 81.4 percent in early November 1974, it compared very favorably with the 79.1 percent average rate in the fall of 1972. And the dip in capacity utilization triggered a swing to cost reduction as the primary motive behind the responding plants' 1975 equipment investment plans. Forty-five percent of the respondents gave this as their No. 1 objective.

For those plants not operating at capacity, the pressures have eased—only 32.4 percent of the respondents are experiencing manpower shortages compared to 58.6 percent a year ago; 46.6 percent continue to experience parts and materials shortages (compared to 53.4 percent last year), 13.6 percent (vs. 16.4 percent) are experiencing excessive maintenance problems, but 31.2 percent (up from 23.1 percent) are experiencing a sales decline.

** Considered for the purpose of this survey to be plants reached by PRODUCTION Magazine in: Fabricated Metal Products (SIC 34); Machinery, except Electrical (SIC 35); Electrical Machinery (SIC 36); Transportation Equipment (SIC 37); Instruments (SIC 38); and Miscellaneous Manufacturing (SIC 39).*

## Here's How 20 Different Industries Allocate Their Capital Equipment Dollar

| | SIC 342 | | SIC 344 | | SIC 345 | | SIC 346 | | SIC 352 | | SIC 353 | | SIC 354 | | SIC 355 | | SIC 356 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 |
| METALCUTTING MACHINES | 26.1% | 20.5% | 13.1% | 6.6% | 37.1% | 52.8% | 15.3% | 11.1% | 36.7% | 21.5% | 47.2% | 44.8% | 69.1% | 71.7% | 55.9% | 57.9% | 52.9% | 56.4% |
| ASSEMBLY EQUIPMENT | 17.6 | 18.9 | 14.5 | 13.2 | 9.2 | 6.8 | 13.6 | 7.5 | 5.4 | 5.9 | 7.4 | 5.1 | 3.4 | 3.7 | 5.5 | 4.2 | 8.7 | 7.8 |
| METALFORMING MACHINES | 18.0 | 19.7 | 22.6 | 27.9 | 19.6 | 16.0 | 29.9 | 48.1 | 20.2 | 20.3 | 15.2 | 15.3 | 7.5 | 9.1 | 12.4 | 13.3 | 9.4 | 11.6 |
| MATERIAL HANDLING EQUIPMENT | 7.9 | 6.1 | 15.4 | 13.8 | 4.8 | 4.6 | 8.7 | 6.9 | 11.9 | 16.9 | 8.9 | 9.3 | 3.9 | 3.9 | 5.7 | 6.5 | 5.5 | 6.2 |
| CLEANING/FINISHING EQUIPMENT | 8.3 | 11.9 | 5.6 | 8.6 | 7.7 | 5.8 | 9.4 | 6.8 | 8.0 | 12.3 | 5.2 | 3.8 | 1.2 | 1.9 | 2.8 | 0.8 | 4.0 | 4.2 |
| WELDING | 4.3 | 3.7 | 14.9 | 11.7 | 1.1 | 1.0 | 4.0 | 3.9 | 5.8 | 10.9 | 8.4 | 9.9 | 1.8 | 1.4 | 3.9 | 7.4 | 3.4 | 3.8 |
| GAGING/INSPECTION/TESTING | 2.5 | n.a.* | 1.9 | n.a. | 1.6 | n.a. | 2.4 | n.a. | 3.6 | n.a. | 1.7 | n.a. | 3.7 | n.a. | 4.5 | n.a. | 4.6 | n.a. |
| PLASTIC MOLD-FORM EQUIPMENT | 1.5 | 4.2 | 1.5 | 1.6 | 3.1 | 1.0 | 1.8 | 1.9 | 0.1 | 0.5 | — | 1.2 | 0.9 | 1.3 | 0.5 | 3.0 | 0.8 | 0.4 |
| HEAT TREATING EQUIPMENT | 6.5 | 4.4 | 0.4 | 0.4 | 5.9 | 3.4 | 3.8 | 2.7 | 1.2 | 3.2 | 2.1 | 2.8 | 2.2 | 2.3 | 1.7 | 0.9 | 3.9 | 1.6 |
| ALL OTHER | 7.2 | 8.6 | 10.1 | 15.8 | 10.0 | 3.3 | 10.9 | 9.7 | 7.1 | 5.8 | 3.9 | 7.8 | 5.4 | 4.3 | 7.0 | 4.7 | 6.9 | 7.5 |

**not available*

Cutlery, Hand Tools, Hardware (SIC 342)
Fabricated Structural Metal Products (SIC 344)
Screw Products (SIC 345)
Metal Forgings & Stampings (SIC 346)
Farm and Garden Machinery (SIC 352)
Construction and Material Handling Equipment (SIC 353)
Metalworking Machinery (SIC 354)
Special Industry Machinery (SIC 355)
General Industrial Machinery & Equipment (SIC 356)
Business Machinery (SIC 357)

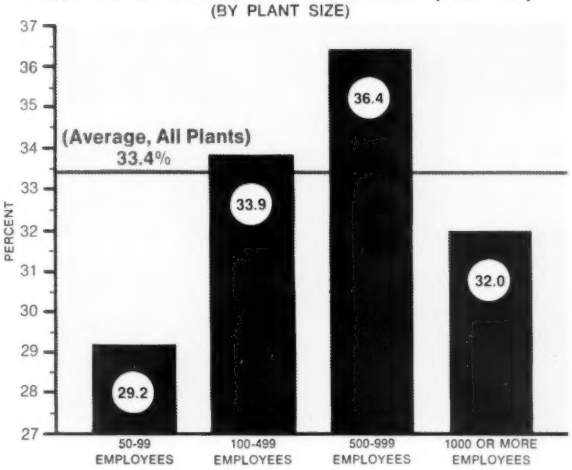
Increased capacity, however, is still a primary motive for 41 percent of the respondents; quality improvement is cited by only 9 percent of the responding plants. The trend of government regulations as a motive to spend continues to decline with only 4 percent citing this as a primary motive and 7 percent as secondary. Fewer plants each year—11 percent in 1974 vs. 13 percent in 1973 and 15.6 percent in 1972—have cited government regulations as their primary or secondary motive for spending. This suggests that most of these often-non-productive investments now have been made.

It is significant, in light of current business trends, that 49.4 percent of the responding plants report they will increase their capital spending in 1975. While 14.3 percentage points lower than the size of the group increasing its spending in 1974 compared to 1973, the group is about the same size as that increasing its spending in 1973 over 1972. Obviously, a large number of plants continue to consider it necessary to invest in equipment as a means to remaining competitive, productive, and profitable.

The 22.5 percent of the respondents whose equipment and machinery investments will be smaller in 1975 than they were in 1974 cite these reasons for their spending curtailment: adequate machine capacity (63.5%); profit decline (30.3% vs. 19.2% last year); sales decline (38.6% vs 9.6%); and capacity exceeding needs (15.2% vs. 7.3% last year).

Purse strings have been tightened. This is demonstrated by the rise of first-year return-on-investment requirement to 33.4 percent—up from 32.2 percent a year ago. The 1.2 percentage-point increase equals almost a 4 percent increase on the base. Plants employing 100 to 1000 have a higher average first-year

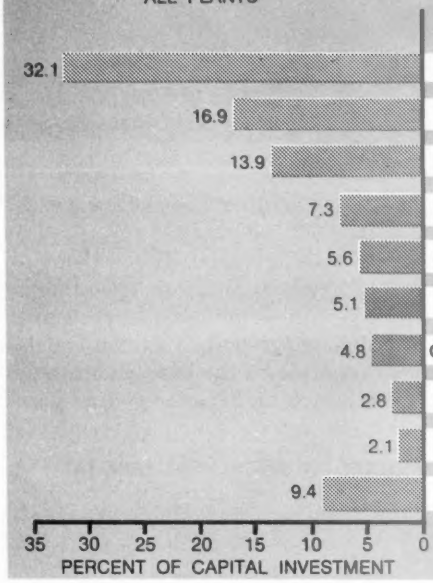
**FIRST YEAR RETURN ON INVESTMENT (PRE-TAX)**
(BY PLANT SIZE)




| SIC 357 | | SIC 358 | | SIC 359 | | SIC 362 | | SIC 363 | | SIC 366 | | SIC 367 | | SIC 371 | | SIC 372 | | SIC 382 | | SIC 386 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 | 1975 | 1974 |
| 19.5% | 28.3% | 14.0% | 17.3% | 61.1% | 65.7% | 32.1% | 37.1% | 2.8% | 4.0% | 21.2% | 17.5% | 11.3% | 9.7% | 28.7% | 30.2% | 45.6% | 54.5% | 28.9% | 41.1% | 28.9% | 36.9% |
| 25.8 | 22.3 | 20.6 | 16.8 | 3.0 | 5.6 | 15.1 | 14.2 | 17.3 | 13.0 | 31.3 | 30.8 | 38.3 | 38.3 | 21.6 | 16.0 | 6.8 | 8.2 | 20.1 | 20.0 | 21.7 | 12.5 |
| 7.9 | 13.6 | 17.6 | 23.9 | 10.9 | 11.7 | 13.5 | 15.1 | 23.3 | 22.1 | 8.7 | 15.4 | 6.0 | 12.9 | 15.1 | 15.6 | 13.4 | 7.1 | 10.9 | 6.7 | 15.4 | 24.7 |
| 5.8 | 6.3 | 12.7 | 11.8 | 5.7 | 5.1 | 6.9 | 7.3 | 9.2 | 13.0 | 7.6 | 4.7 | 4.6 | 5.3 | 9.3 | 10.1 | 7.0 | 5.5 | 4.2 | 6.2 | 5.9 | 6.3 |
| 7.4 | 6.7 | 6.3 | 3.4 | 3.0 | 1.6 | 4.4 | 3.3 | 7.4 | 18.2 | 6.7 | 5.0 | 8.2 | 9.7 | 3.9 | 6.7 | 6.7 | 7.5 | 5.0 | 9.1 | 3.1 | 3.0 |
| 2.6 | 2.9 | 10.8 | 10.0 | 7.4 | 4.4 | 3.2 | 3.9 | 6.3 | 2.0 | 2.9 | 3.8 | 3.5 | 4.2 | 7.3 | 7.6 | 4.9 | 1.4 | 2.9 | 2.6 | 2.3 | 5.9 |
| 15.7 | n.a. | 3.2 | n.a. | 5.8 | n.a. | 6.8 | n.a. | 1.7 | n.a. | 11.1 | n.a. | 7.9 | n.a. | 4.5 | n.a. | 4.7 | n.a. | 6.6 | n.a. | 5.5 | n.a. |
| 3.6 | 0.5 | 2.4 | 1.8 | 1.0 | 0.1 | 3.6 | 4.7 | 15.7 | 6.2 | 3.0 | 2.3 | 5.4 | 5.7 | 0.5 | 1.0 | 0.6 | 1.9 | 7.0 | 5.0 | 12.3 | — |
| 1.2 | 1.0 | — | — | 0.2 | 1.4 | 2.2 | 1.0 | 0.7 | 2.7 | 1.0 | — | 1.9 | 1.8 | 2.6 | 4.4 | 2.6 | 6.1 | 1.0 | 0.9 | — | — |
| 10.3 | 16.6 | 12.4 | 14.1 | 1.9 | 3.8 | 12.1 | 12.3 | 15.5 | 14.3 | 6.4 | 19.3 | 12.9 | 9.6 | 6.4 | 10.7 | 7.8 | 5.9 | 13.4 | 5.8 | 4.7 | 10.7 |

Refrigeration and Service Industry Machinery (SIC 358)
Miscellaneous Machinery, Except Electrical (SIC 359)
Electrical Industrial Apparatus (SIC 362)
Household Appliances (SIC 363)
Communications Equipment (SIC 366)
Electronic Components & Accessories (SIC 367)
Automotive (SIC 371)
Aircraft & Parts (SIC 372)
Measuring & Controlling Instruments (SIC 382)
Photographic Equipment & Supplies (SIC 386)

## HOW THE 1975 CAPITAL EQUIPMENT DOLLAR WILL BE SPENT




| | PLANT SIZE | | | |
|---|---|---|---|---|
| | 50-99 EMPLOYEES | 100-499 EMPLOYEES | 500-999 EMPLOYEES | 1000 OR MORE EMPLOYEES |
| METAL CUTTING MACHINES | 39.2 | 30.8 | 30.7 | 29.7 |
| ASSEMBLY EQUIPMENT | 12.5 | 17.8 | 18.4 | 16.9 |
| METAL FORMING MACHINES | 14.9 | 14.6 | 11.6 | 13.2 |
| MATERIAL HANDLING EQUIP. | 6.8 | 7.3 | 7.7 | 7.5 |
| CLEANING/FINISHING EQUIP. | 6.6 | 5.9 | 3.8 | 5.4 |
| WELDING | 5.3 | 5.2 | 5.0 | 4.5 |
| GAGING/INSPECTION/TESTING | 4.7 | 4.4 | 4.9 | 6.3 |
| PLASTIC MOLD-FORM EQUIP. | 1.7 | 2.6 | 4.1 | 3.4 |
| HEAT TREAT EQUIP. | 1.1 | 2.0 | 2.8 | 2.7 |
| ALL OTHER | 7.2 | 9.4 | 10.9 | 10.3 |

return requirement than all plants, while those plants employing 50 to 99 and those with over 1000 employees have lower ROI requirements. And, it's these plants—ones in the 100-to-1000-employee bracket—which are the backbone of the 1975 machinery and equipment expenditures.

**How the Money Will Be Spent.** As has been the case in the last 10 years, metalcutting machine tools will capture the largest share of the 1975 capital equipment dollar (32.1%). This will amount to $1.37 billion, which approximates the metalcutting machine tool building industry's shipments to domestic plants during 1974. However, assembly machinery and equipment now have moved into second position in the capital investment budget, displacing metalforming equipment. Such equipment accounts for 16.9 percent, or $721 million of the 1975 budgets. Metalforming equipment at 13.9 percent and $594 million is in the third spot. Materials handling equipment will account for 7.3 cents of the investment dollar; finishing equipment, 5.6 cents; welding/riveting/brazing equipment, 5.1 cents; gaging/inspection/testing equipment, 4.8 cents; plastic molding machinery, 2.8 cents; and heat treating equipment, 2.1 cents. The remaining 9.4 percent ($401 million) is primarily slated for OSHA/EPA-related items and for machine and production control.

**AVERAGE CAPITAL EQUIPMENT INVESTMENT**

| PLANT SIZE | 1975 AVERAGE $ PER PLANT | 1974 AVERAGE $ PER PLANT | 1973 AVERAGE $ PER PLANT |
|---|---|---|---|
| 50-99 EMPLOYEES | $ 79,122 (-30.7%) | $ 114,098 | $ 67,600 |
| 100-499 EMPLOYEES | 244,865 (- 7.5%) | 264,662 | 165,400 |
| 500-999 EMPLOYEES | 479,225 (+16.6%) | 411,146 | 367,500 |
| 1000+ EMPLOYEES | 737,114 (-45.7%) | 1,358,312 | 969,500 |

**NC Spending Plans.** Numerically controlled equipment purchases, as a proportion of metalcutting and metalforming machine purchases, should grow significantly in 1975 with 30.3 percent of the responding plants (up from 26.6% last year) planning to buy NC equipment in 1975.

As in past years, the vast majority (78.8%) of plants intending NC purchases already are NC users and operate, on the average, 9.6 machines per plant. Of all the respondents, 40.7 percent currently operate NC equipment and average 7.9 NC machine tools per plant. This represents 15 percent of all NC machines (35,000) installed in industry since 1955.

The typical NC user who is expanding its use of NC in 1975 is operating at 85.1 percent capacity (against the all-plant average of 81.4%); it will spend $755,780 in 1975 for machinery and equipment; it allocates 54.6 percent of its capital investment to metalcutting machines and 9.4 percent to metalforming equipment; it is medium-sized to large (91.9 percent of these plants employ more than 100 persons); it will be buying more than one type of NC equipment.

The typical first-time purchaser of NC in 1975, on the other hand, is operating at 82.5 percent; it will spend $400,470 in 1975 for machinery and equipment; it allocates 45.1 percent of its capital investment to metalcutting machines and 16.6 percent to metalforming equipment; and, unlike the present NC user, will tend to buy one type of NC equipment. This

first-time NC user also is medium-sized to large (82.9 percent of the plants thus responding employ 100 or more).

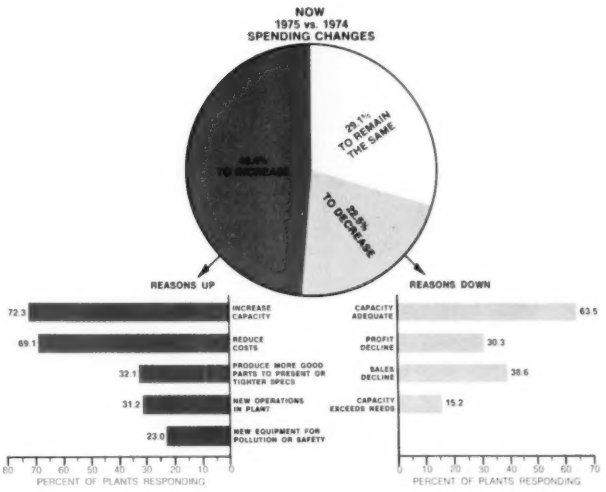
There will be a decline in NC buying in 1975 among smaller plants; of the plants that will be buying in 1975, only 10.2 percent employ less than 100 persons. Last year, 24.5 percent in that size category indicated plans to buy NC.

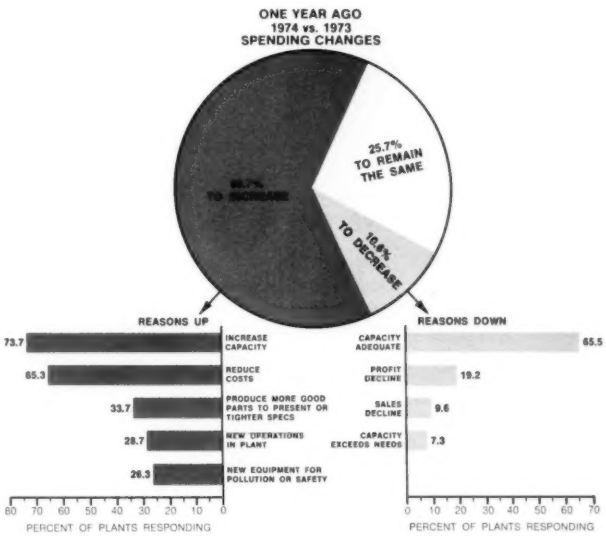
The types of NC equipment to be purchased in 1975 are depicted with the percentages relating the equipment type to the plants which are indicating NC purchases in 1975: turning equipment, 35.3 percent; machining centers, 40.2 percent; drilling machines, 22.9 percent; milling machines, 21.3 percent; punching machines, 15.5 percent; boring machines, 11.8 percent; profiling machines, 6.2 percent; bending machines, 5.0 percent; other types including measuring, riveting, etc., 8.2 percent.

**Computer Use Increases.** Use of computers and minicomputers to control production equipment is now reported by 13.2 percent (up from 7.4% a year ago) of the survey's total respondents. Some 8.4 percent say they plan purchases of such equipment in the next two years. An additional 1 percent of the plants are considering use of such equipment but do not have it in their investment plans at this point.

**What They're Looking For.** The companies that are increasing their equipment spending in 1975 are aiming, primarily, at increasing their capacity (72.3%); buying new machines to reduce costs (69.1%); increasing the quantity of good parts produced to present or tighter specifications (32.1%); putting new operations in their plants for parts formerly procured from the outside (31.2%); and adding pollution control/safety equipment/facilities (23.0%).

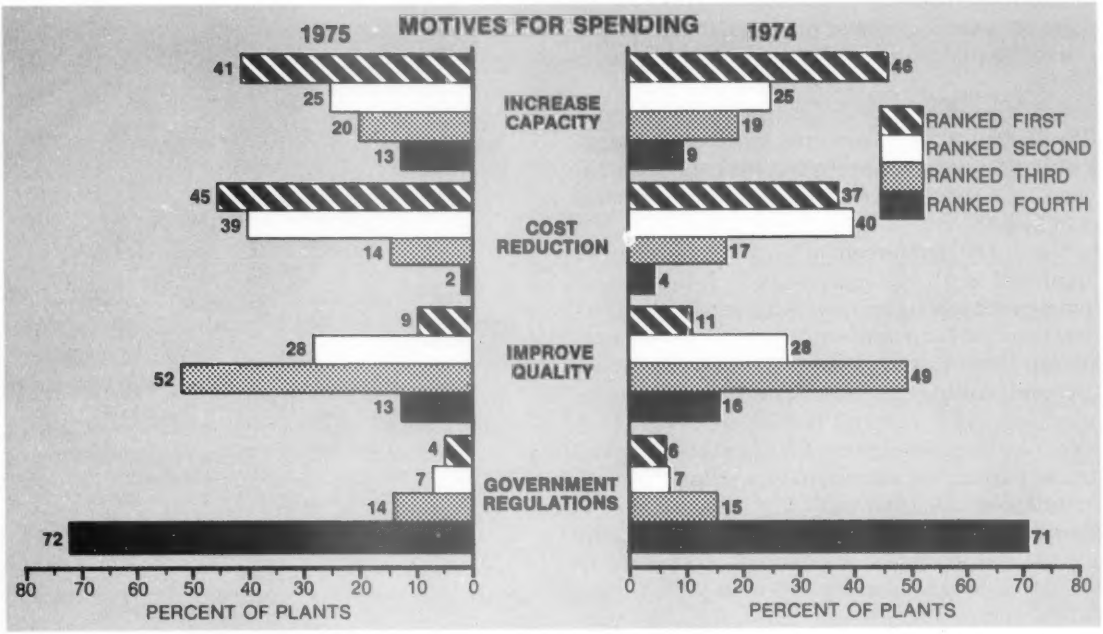
Digging a little deeper into the spending motives of all the responding plants (not just those increasing their investments in 1975), the survey shows the fol-




**PROJECTED 1975 CAPITAL EQUIPMENT INVESTMENT**
**By Equipment Type and Plant Size**

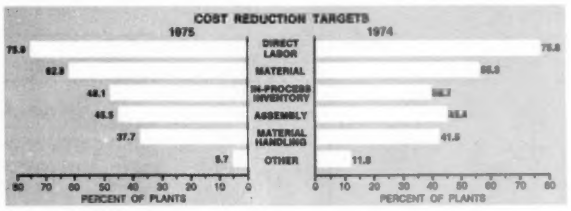
| | PERCENTAGES | | | | | |
|---|---|---|---|---|---|---|
| | 50-99 EMPLOYEES | 100-499 EMPLOYEES | 500-999 EMPLOYEES | 1000+ EMPLOYEES | TOTAL $ (millions) | 1975 vs. 1974 (percentage change) |
| METAL CUTTING | 39.2% | 30.8% | 30.7% | 29.7% | $1,370.7 | - 28.0% |
| ASSEMBLY | 12.5 | 17.8 | 18.4 | 16.9 | 721.6 | - 14.6 |
| METAL FORMING | 14.9 | 14.6 | 11.6 | 13.2 | 593.5 | - 35.4 |
| MATERIAL HANDLING | 6.8 | 7.3 | 7.7 | 7.5 | 311.7 | - 32.9 |
| FINISHING | 6.6 | 5.9 | 3.8 | 5.4 | 239.1 | - 33.3 |
| WELD/RIVET/BRAZE | 5.3 | 5.2 | 5.0 | 4.5 | 217.8 | - 22.2 |
| GAGING/INSPECTION/TESTING | 4.7 | 4.4 | 4.9 | 6.3 | 204.9 | not surveyed in 1974 |
| PLASTIC MOLDING | 1.7 | 2.6 | 4.1 | 3.4 | 119.6 | - 28.3 |
| HEAT TREATING | 1.1 | 2.0 | 2.8 | 2.7 | 89.7 | - 29.4 |
| OTHER | 7.2 | 9.4 | 10.9 | 10.3 | 401.4 | - 33.9 |
| | | | | | $4,270.0 | - 24.8% |




lowing as major avenues being taken toward optimizing cost-quality-capacity:

- Rearranging operations to shorten supply lines, reduce material handling, and cut in-process inventory (62.4%);
- Adopting processes/machines/materials that minimize process requirements (43.4%);
- Performing more operations in-plant that previously had been done outside (41.3%);
- Setting up, or planning to set up, computerized production control systems (35.0%);
- Establishing separate production areas to handle special or low-volume jobs, service parts, special orders, etc. (30.2%);
- Purchasing from outside sources parts/products previously produced in-house (18.5%).

The higher percentage of companies now bringing more work into their plants reverses a three-year




trend. This confirms that capacity pressures have eased, and indicates that these plants are seeking to operate at more efficient levels of output. Also worthy of note is that 12 percent of the responding companies say they are reconstituting some of their production line jobs to add variety to the work and reduce boredom. A higher percentage (16.6%) says they are setting up new or different incentive systems.

Reduction of direct labor continues as the major cost-reduction target of the responding plants, as it has been since 1971. It is cited by 75.6 percent, about the same as last year.

Reducing the cost of materials continues its upward trend for concentrated attention, with 62.8 percent of the responding plants (up from 55.3% in 1974 and 49.6% in 1973) listing this as a major objective. Reducing in-process inventory (48.1%), assembly costs (45.5%), and material handling costs (36.7%) are also cited by responding plants as major 1975 objectives.

**Stacker Cranes and Robots.** The survey this year looks at a new segment of material handling equipment—storage/retrieval systems (stacker cranes). Of plants responding to the survey, 11.6 percent say they are investigating, or planning to install, storage/retrieval systems in 1975.

While interest is high across most of the industries surveyed, eight industry groups will account for 55.0 percent of the activity. These include: Fabricated Structural Steel (metal doors, sash and trim, sheet metal work); Miscellaneous Fabricated Metal Products (steel springs, valves and pipe fittings, wire products); Construction, Mining, and Materials Handling Equipment; Metalworking Machinery and Equipment; Special Industry Machinery; General Industrial Machinery and Equipment (pumps, compressors, bearings, mechanical power transmissions); Electrical Industrial Apparatus (motors, generators, controls); Motor Vehicles and Motor Vehicle Parts and Accessories. Of the plants investigating or planning to install storage/retrieval systems, 91.6 percent employ over 100 employees.

Only 5.1 percent of the responding plants include purchase of universal transfer devices (industrial robots) in their 1975 spending plans. Activity is centered in the following industry groups where 61.9 percent of those plants intending to purchase UTDs are located: cutlery, hand tool and hardware makers; metal stampers; construction, mining and materials handling equipment; general industrial machinery (pumps, bearings, compressor manufacturers); motor, generator, and controls builders; electric lighting and wiring manufacturers; electronic components makers; and motor vehicle and parts and accessories manufacturers.

**Assembly Machines.** Direct labor reduction is the prime cost-reduction target for 1975, and the assembly operation, with its heavy direct labor content, is capturing a larger share of attention and of capital dollars—16.9 cents, up from 13.7 cents a year ago. This will amount to $721 million, of which we estimate $120 million will be allocated for semiautomatic and automatic assembly machines and equipment. Higher return on investment requirements also tend to favor the expenditures in this direction.

Investment activity is centered in the following industries: cutlery, hand tools and hardware, (SIC 342); metal forging and stamping (SIC 346), (doubling the investment for this equipment compared to one year ago); business machines, including computers (SIC 357), (accounting for one quarter of all machinery and equipment investments in this market); refrigeration and air conditioning (SIC 358); electrical household appliances (SIC 363); communications equipment (SIC 366); electronic components (SIC 367); measuring and controlling instruments (SIC 382); and photographic equipment (SIC 386).

Location of assembly investment by plant size is indicated in the survey as follows: 12.5 percent in plants employing less than 100; 17.8 percent in plants employing 100-499; 18.4 percent in plants employing 500-999; and 16.9 percent in plants employing 1000 and more.

**Gaging-Inspection-Testing Equipment.** Not measured in previous surveys as a specific category, gaging-inspection-testing machines and equipment seem to be increasing in importance and in 1975 will account for 4.8 percent of total machinery-equipment capital investment. This amounts to $204.9 million.

While the funds allocated are well-spread over all size plants, the largest employers (1000 or more) will spend 31 percent more on gaging-inspection-testing machines than the typical plant and will spend 6.3 cents of every capital dollar in this category. They are followed by plants employing 500-999, which will spend 4.9 cents. Plants employing 100-499 and those employing less than 100 will allocate 4.4 percent and 4.7 percent, respectively, for this equipment.

Industries spending more than the average of 4.8 percent for gaging-inspection-testing equipment are shown in the following table:

| SIC Industry | | Percent of Total Capital Expenditure for Gaging-Inspection-Testing |
|---|---|---|
| 348 | Ordnance and Accessories, exc. Vehicles and Guided Missiles | 8.3% |
| 357 | Business Machines (Incl. Computers) | 15.7% |
| 359 | Misc. Machinery, exc. Electrical | 5.6% |
| 361 | Electrical Transmission and Distribution Equipment | 6.4% |
| 362 | Electrical Industrial Apparatus | 6.8% |
| 366 | Communications Equipment | 11.1% |
| 367 | Electronic Components and Accessories | 7.9% |
| 369 | Miscellaneous Electrical Machinery, Equipment, Supplies | 7.7% |
| 382 | Measuring and Controlling Instruments | 6.6% |
| 384 | Surgical, Medical, and Dental Equipment and Supplies | 8.8% |
| 386 | Photographic Equipment and Supplies | 5.5% |

**Plastic Molding Equipment.** While the respondents in total indicated that 2.8 percent of their machinery-equipment investment dollars are slated for plastic molding and forming equipment, most of the installations of this type equipment will take place in a dozen industry groups. These are shown in the following table:

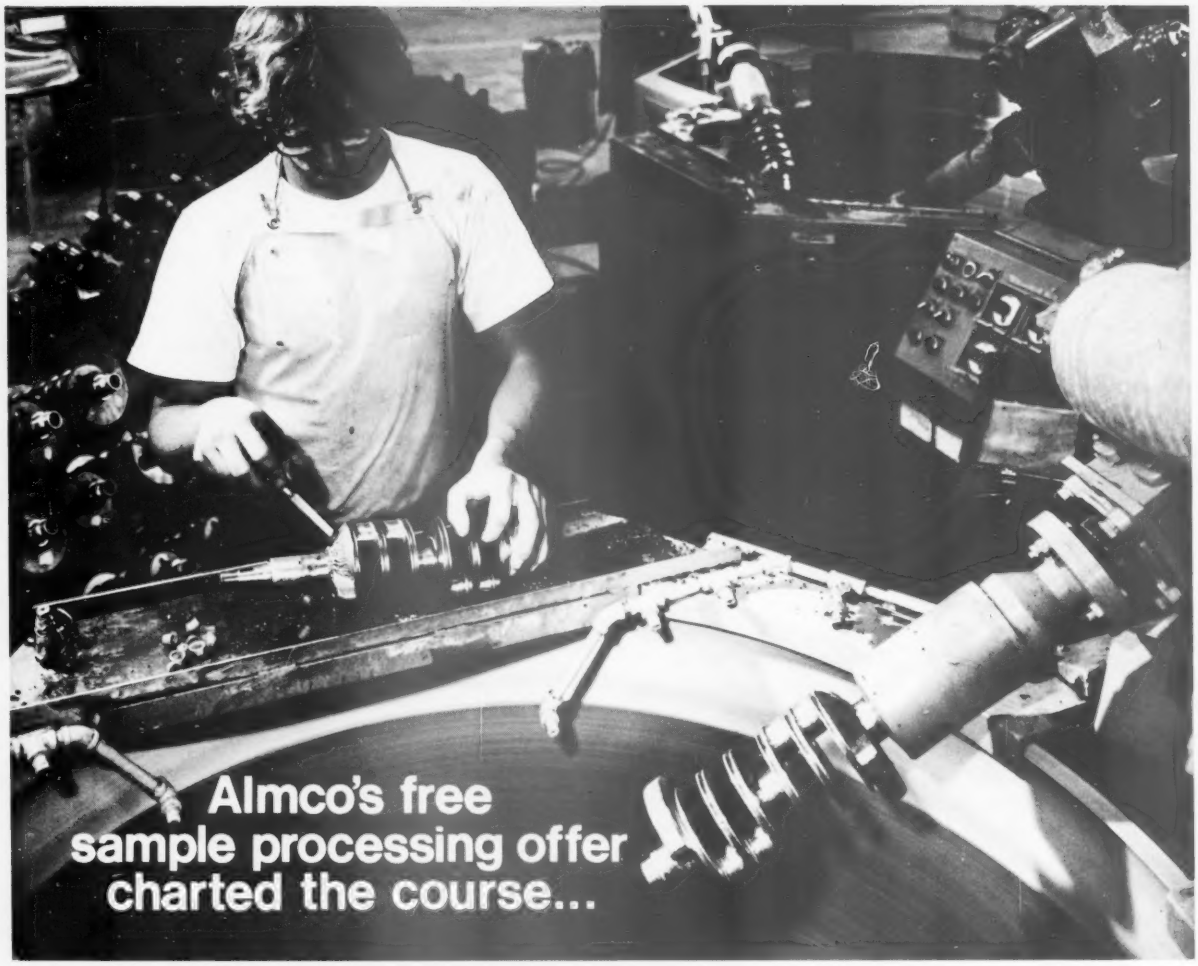
| SIC Industry | | Expenditure Percent of Total Capital for Plastic Molding |
|---|---|---|
| 361 | Electrical Transmission and Distribution | 4.9% |
| 362 | Electrical Industrial Apparatus | 3.6% |
| 363 | Household Appliance | 15.7% |
| 364 | Electric Lighting and Wiring Equipment | 6.6% |
| 367 | Electronic Components and Accessories | 5.4% |
| 369 | Misc. Electrical Machinery, Equipment, Supplies | 8.4% |
| 381 | Engineering, Laboratory, Scientific and Research Instruments | 8.1% |
| 382 | Measuring and Controlling Instruments | 7.0% |
| 383 | Optical Instruments and Lenses | 10.0% |
| 384 | Surgical, Medical and Dental Instruments | 6.3% |
| 386 | Photographic Equipment | 12.3% |
| 394 | Toys, Sporting and Athletic Goods | 18.3% |

It is likely more plants would be increasing their expenditures for plastic equipment if they were assured adequate future supplies of resins.

**In Summary.** While there is a fair chance some of the equipment-improvement projects originally budgeted for 1975 will not be immediately installed because of business conditions and equipment price increases, the survey nevertheless indicates the basic strength of the metalworking industries' commitment to improve their facilities and their ability to meet more rigorous first-year return on investment criteria with their investment proposals.

Their indicated emphasis on cost reduction and on asset utilization furthermore is likely to intensify under the near-term economic outlook, giving urgency to most of their plans. The somewhat easier money supply also favors realization of these plans.

Obviously, while recession is today's most widely discussed topic, the persons responsible for making the metalworking industries' longer-range plans are acting on logic, not in panic. Belt-tightening, yes. Bootstrap-lifting, sure. But running for the economic storm cellar, not a bit! ■




# Now Evinrude's making waves with 80% lower parts finishing costs!

"We explored several alternatives for eliminating costly multiple hand operations and improving the consistency of finish on our cast steel crankshafts. Almco's sample processing convinced us spindle deburring was the way to go." This is the observation of Norman Krueger, Methods Engineer at Evinrude Motors Division, Outboard Marine Corporation, Milwaukee, Wisconsin.

Since Evinrude's initial order for two Almco 2SF-48A dual-spindle machines — installed in December, 1973 — the company has placed two additional orders, for a total of 6 machines in all.

Consider the results: Finishing of Lawn Boy engine crankshafts used to require three shifts involving 3 to 5 different benchwork operations. *Now one operator, working two machines, does it all in a single shift.* Similarly, one man and one shift are all it takes for finishing larger outboard crankshafts.

Evinrude realized an 80% cost savings on finishing operations with improved quality, reduced cost, and minimal rejects. With fewer reruns, there also has been a substantial reduction of lead time required for product deliveries.

When we ordered the machines," says Krueger, "we projected they would pay for themselves within a year. Now it appears they'll do even better."

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# Planning for METRICATION

**The least difficult aspect of a metric conversion is "learning to speak metric." Yet this is what most metrication information emphasizes. Before that, some basic decisions are needed**

Metrication. Some observers call it an organization's most pervasive and complicated change short of a wartime conversion. Others call it surprisingly simple . . . but then stress the need for highly detailed planning and follow-through.

Whether one statement or the other is right is inconsequential. Both indicate that a company's metrication takes an immense amount of brain work and involves, in some way, every person in the organization. Planning is the single most important element.

The subject of conversion to metrics is, for most companies in the United States, a we'll-cross-that-bridge-when-we-come-to-it topic. However, according to a survey of its member companies by the National Association of Manufacturers, at least 400 have reached the point of designating a "metric coordinator," a "metrication study coordinator," or a similarly titled person. Other groups have counted some 30 major companies that have publicly announced their decision to metricate. Undoubtedly, a larger number have privately made the same decision and are at some early point on their conversion timetables.

In a way, what's happening in the United States is like what happened in Great Britain. There, the initial push for metrication came from private industry through its Board of Trade organization; the government decision for a national conversion followed industry's economic arguments. Here, in the U.S., following fairly strong governmental support that bogged down in a Watergate-bemused Congress and Administration and encountering labor and small business opposition to a "let costs lie where they fall" conversion doctrine, the metrication initiative passed to large multinational industries, with the field of education becoming a growing force.

As with England's trade-minded companies, economic considerations have given the impetus to those U.S. companies engaged in conversion. Also involved is the "inevitability" factor, often cited in company policy statements as an important reason for the planned conversion. This contends that, like it or not, the U.S. will ultimately adopt a national policy favoring the metric system to bring it into step, from a measurement standpoint, with the rest of the world.

By all indications, however, the U.S. will remain for another generation a two-measuring-system country, as it has been since 1866 when, by law, the metric system became an accepted measuring system along with the "customary" or English system.

It is presupposed that eventually Congress will pass legislation similar to that which has previously been passed by either the House or the Senate (but not by both and enacted). Such legislation would call for a "predominantly metric" U.S., not an "exclusively metric" country. The period during which the metric system would become predominant has generally been put at 10 years in most legislative proposals, but efforts were made last year in the House to have the proposed conversion period stretched to 15 years.

For those companies which are beginning to think it may be to their advantage to consider the metric question in depth some suggestions on how they should proceed may be helpful.

## I. HOW TO START

The fundamental act in a company is a decision that the metric measuring system needs to be thoroughly explored and its present and likely future relation to the company's operations and markets understood. This requires, initially, designating one person to take charge of this study.

For some 2000 manufacturing companies, an important start was made when they accumulated the data to answer the comprehensive questionnaire sent to them by the U.S. Commerce Department's National Bureau of Standards as part of the U.S. Metric Study, whose report was transmitted to Congress in 1971.

This questionnaire requested companies to determine the degree to which metric measurements are already being used in their research and development activities, in product design/engineering activities, in manufacturing operations, in packaging/labelling activities, and in catalog literature.

It asked the degree to which metric engineering standards for various key components and materials are being used. It asked whether the organization has manufacturing operations overseas or foreign af-

filiates which are using metric units and/or metric engineering standards. And it asked the amount of exports using metric units.

To develop their replies, the responding companies obviously got a better handle on where, and the amount to which, metric measuring units and metric engineering standards are already being employed. And by the questionnaire's listing of functional areas and its request for comments about the favorable and unfavorable effects of metrication in each of these areas, it enabled respondents to think through where cost advantages/penalties would be likely to occur in their companies.

**Sources of Information.** It would be advantageous to a company now beginning to consider whether it will metricate, and trying to decide how it will approach its information-gathering phase, to use parts of the NBS questionnaire as a basic checklist. (The questionnaire is published as an appendix to the U.S. Metric Study Interim Report on the Manufacturing Industry, which is available [as SD Cat. No. C13.10:345-4] from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, or from U.S. Commerce Department field offices, for $1.25.)

An invaluable listing of other references pertaining to the metric system is available for $.25 from the Superintendent of Documents or Commerce Department field offices, designated NBS Special Publication 389, "Some References on Metric Information." This lists, in addition to government-published reports, six pertinent publications by the American National Standards Institute, and also provides the names and addresses of 80 organizations which publish metric informational materials.

Several of these organizations publish magazines or newsletters on the subject of metrics. One merits special attention here because of its concentration on the industrial and commercial segments of society, its non-profit nature, and its relationship to the voluntary American National Standards Institute. This is the American National Metric Council, 1625 Massachusetts Ave. N.W., Washington, D.C. 20036.

**ANMC's Role.** ANMC is nonadvocate—it is not promoting adoption of the metric system or retention of the customary, English system. It, however, is active in the interchange and publication of information, in part through its "Metric Reporter" newsletter; and, with over 200 companies and organizations participating in its work, it is structured into five coordinating committees and 30 industry sector committees.

Its current activities include "analysis of metric units to be used in industry; identification of laws and codes needing amendment to allow for conversion; identification of areas in which soft conversion is appropriate and where hard conversion presents an opportunity; and . . . identification of elements of a minimum cost conversion strategy for respective industries. Analysis is also ongoing of appropriate metric engineering standards which will be required."

Its executive director, Dr. Malcolm E. O'Hagan, was recruited from Bendix Corp.'s Automation & Measurement Division, where he had been product manager, Cordax measuring machines and systems.

The organization will hold its first annual conference and exposition Mar. 17-19 at the Washington Hilton, Washington, D.C., with topics to include economics of conversion, legislative outlook, metric usage, and impact of metrication on engineering standards, education, and particular industry/commercial/governmental sectors. A special feature will be two half-day sessions organized by the Industrial Fasteners Institute on the Optimum Metric Fastener System.

**Trade/Professional Associations.** Fundamental in a company's consideration of metrication is knowledge of the pertinent activities within its industry and within the professional associations to which its key personnel belong.

While each of these groups functions differently and views its involvement in the metrication situation differently, all have considerable helpful information available to their members. Among the professional and industry organizations, many —estimated at about 400—are involved in standards-making, and there are reported to be 20,000 national U.S. standards—mostly customary system-based—now in existence.

Conversion by a manufacturing organization to the metric system involves two distinct, broad functions—change in measuring units and change in engineering standards, with the former being relatively easy and fast compared to the latter.

**Where Standards Originate.** U.S. companies'/industries' concern with standards has increased enormously as various other countries and trading blocs have put more of their influence into development of self-serving standards. Two primary organizations are responsible for development of "in-

ternational" standards, the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), with the U.S.'s interests being represented in both by members of ANSI.

Over the next five years, some 5000 to 10,000 recommended international standards will be drafted by ISO and IEC, and the metric International System of Units (SI) will be required in all such recommended standards.

To facilitate consideration of their standards for internationalization and to bring their work into greater conformity with similar work being done in other countries, such domestic standards-making bodies as the American Society for Testing Materials, the American Society of Mechanical Engineers, the Society of Automotive Engineers, and others now are requiring or recommending inclusion of SI units as well as customary units in the standards they develop.

To the extent a company depends upon external standards, it already has considerable knowledge somewhere in its organization about those where the metric influence has been or soon will be felt. One of the important early duties of a person charged with pulling together metric information will be to acquaint himself with the status of these standards.

It became evident at some companies' early conversion planning that the standards-making organizations are not able to function fast enough or in enough directions simultaneously to meet their internal informational needs. (Typically, a voluntary national standard is two years in development and an international standard is about six years in the making.) With many large multinational companies trying to reach a 50 percent metrication objective in five years and virtual completion of their conversion within 10 to 15 years, the traditional standards-making pace is entirely too slow.

Thus, Ford Motor Co. and General Motors Corp., for example, with extensive and comprehensive internal standards, have been forced to develop their own metric and hybrid standards as guides to their engineering groups and to their suppliers and potential suppliers.

Companies such as these are willing in most instances to share their work with others and to be extremely open in discussing their problems and approaches in the metrication effort. A major source of information on who is involved with metrication and the experiences they are having is ANMC, through its "Metric Reporter" and its now-being-compiled list of company metric coordinators.

**Consult a Consultant?** When anything as new and potentially disruptive as a metric conversion begins to loom on the industrial horizon, many self-styled consultants simultaneously appear.

The PLANBOOK surveyed the persons who are listed as "metric consultants" in one of the periodicals devoted to metrication activities. Most of the individuals are connected with colleges and universities in the mathematics and engineering departments; some are in local school systems.

In their answers, the majority indicated their consultation work is limited to teaching the use of SI units. Only a few deal with the broader—and earlier—requirement of organizing a conversion program.

The director of the University of Missouri-Rolla Graduate Engineering Center in St. Louis, Anton deS. Brasunas, says " 'common sense' is largely the heading under which most metric assistance falls."

Smaller companies, he says, "are concerned with the coordination of metric terminology within their plants as well as the coordination of their production with raw material suppliers and customers of the finished product so that their production picture need not be affected significantly.

"Larger companies and companies that make critical items are primarily concerned about new standards and codes which could effect the entire engineering design of structures . . ."

He adds: "There seems to be very little concern about learning to use millimeters instead of inches and speaking 'the metric language.' This could be learned in time and is not considered to be a problem."

**What To Know, When.** The prevailing rule is: "Teach people only what they need to know, when they need to know it." Early and extensive training is not regarded as necessary.

At the same time, many companies believe it ad-

vantageous to help their employees develop a metric "awareness" and get a preliminary feel for the way measuring systems figure in their personal and workday lives. Commonly, this involves plant posters and plant newspaper articles showing the size of everyday objects in metric measurement units.

As a parallel activity, General Motors Corp., through its Personnel Communications Department, is distributing to its employees a booklet entitled "The Swing to Metric," explaining the background, growth, principles and impact of the metric system, and its application within GM. Many of the publishers listed in NBS's "References on Metric Information" offer similar primer-style booklets for employees' basic familiarization.

Many professional organizations are conducting "Metric Workshops" to increase the familiarity of their members (and others) with the correct usage of the SI units. These usually also provide an overview of the history of various measuring systems and the progress toward a U.S. metric conversion. One of the main benefits a company's metric coordinator will gain from his attendance is the literature he can pick up and the contacts he can make with persons also getting into a conversion study.

Among the outstanding pieces of literature that some trade associations are offering are the National Tool, Die and Precision Machining Association's 60-page book, "Basic Training Guide to the New Metric and SI Units"; and the National Association of Purchasing Management's 159-page book, "The Executive's Guide to Planning Transition to the Metric-SI System." Both books were developed by Robert C. Sellers & Associates, Inc., 131 Tulip Ave., Floral Park, N.Y. 11001. NTDPMA's address is 9300 Livingston Rd., Washington, D.C. 20022; NAPM is located at 11 Park Place, New York, N.Y. 10017.

## II. ORGANIZING THE ATTACK

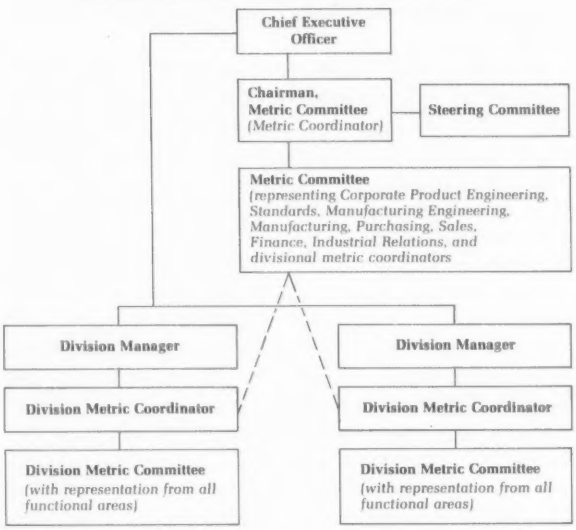
At the outset, we said a metric conversion, in the opinion of some observers, may be a company's most pervasive and complicated change short of a wartime conversion. As such, it is not a job for one man to mastermind even if his company's operations and product line are simple.

The committee approach is the universally followed method to bring the various functions of the organization aboard for the information inputs they can contribute and the coordinated plans they can develop.

Whether this committee's studies will lead to a decision that metrication is not economically advantageous at this time or help the committee to the conclusion that a metrication plan should be developed and implemented, either of these decisions will be of enough consequence that the committee's formation and its activities deserve instigation and support at the company's highest level.

Typically, the committee's chairman will be a

**Typical Organization for Metric Study/Conversion**


Chief Executive Officer
Chairman, Metric Committee (Metric Coordinator)
Steering Committee
Metric Committee (representing Corporate Product Engineering, Standards, Manufacturing Engineering, Manufacturing, Purchasing, Sales, Finance, Industrial Relations, and divisional metric coordinators
Division Manager
Division Manager
Division Metric Coordinator
Division Metric Coordinator
Division Metric Committee (with representation from all functional areas)
Division Metric Committee (with representation from all functional areas)

senior man with extensive knowledge of the company's activities and personnel. Often this is the director of engineering or the top standards man. A "steering committee" of top officials may be useful in giving this chairman his basic guidelines.

The "metric study" or "metric conversion" committee should be composed of representatives from all major functional departments within the organization. Emphasis, however, will be on Product Engineering, Manufacturing Engineering, Manufacturing, Purchasing, and Sales, with Finance and Industrial Relations also participating.

**What To Decide?** As the committee gets its feet wet and gets past accumulating preliminary information on where, in general, metrication stands within the industry in which the company operates, it can begin to get down to the nitty-gritty; namely, determining what the company's officers need to know before they make the decision on whether conversion is to be undertaken.

For some major companies such as General Motors and TRW, the initial studies were almost as detailed as the conversion planning itself would be. GM, for instance, obtained comparative prices of dual-reading gages and dual-capability machine tools against all-metric and all-inch instruments and machines as part of the prelude to deciding on its metrication course.

Other companies have omitted such detailed studies, deciding instead that sooner or later the metric system will become universal and the costs must be borne eventually. They have proceeded on the basis of the assumptions laid down for answering the Bureau of Standards' questionnaire.

These assumptions were that production materials, components, and equipment would be available to metric standards at no substantial increase in cost; that relatively little new equipment or tooling would have to be purchased in advance of normal obsolescence; and that new product designs to metric dimensions would be introduced only when the normal life-cycle of inch-based products had been completed unless there is substantial economic advantage in an earlier change.

These assumptions, companies now making the conversion say, are not completely valid. Metric raw materials from domestic suppliers are not yet widely available; most materials suppliers are in the earliest stages of their own conversion planning and are not yet able to get a fix on the speed with which their main customers will want metricated materials.

Metric components and equipment conversions are much more widely available. There is, however, considerable "hybridization" of perishable tools. (These are to metric measurement at the cutting face and to inch dimensions at the tool holder.)

To cope with these types of problems, General Motors has developed new materials standards, and Ford published a new tool manual outlining specifications for metric (and/or hybrid) drills, reamers, bushings, and taps.

The tool suppliers are using comprehensive charts and tables to show how their tools can be used on metric products with inch-based equipment, and vice versa.

The situation is summed-up well by Joseph P. Masvero, marketing manager, Industrial Tools Division, Bendix Corp.: "Whether we want to metricate or not has actually been taken out of our hands. If we want to stay in business, we are governed by and pushed into metrication by the metrication programs of the metalworking industry, mainly large automotive and farm implement companies and especially those who also operate manufacturing plants in metric countries.

"Several of these companies have approached us, as their suppliers, to submit recommendations on how we can help them with the various levels of their metrication program. We have submitted written proposals and cost estimates tailored to their requirements for metric or semi-metric (hybrid-type) products and explained the extent of our present plans and capabilities. In turn, we have approached (and continue to do so) users to learn about their metrication programs. We find most users quite eager to let us and others in on their plans, policies, guidelines or whatever they may call their metrication activities."

**Sequencing the Conversion.** A newly formed metrication study committee will find, in all likelihood, that it must rough out the sequence a conversion, if undertaken, will follow, and the timing of this sequence. Such a sequence becomes a major part of the company's policy statement if the conversion, itself, is decided upon.

A key question is whether a conversion initially would be "soft" or "hard," soft meaning the translation of the product's inch dimensions into metric equivalents with no change in the physical characteristics of the components, and hard meaning a design throughout in metric modules.

Pullman Inc.'s division, M.W. Kellogg Co., Houston, Tex., has elected to take a three-phase approach. As an engineering and construction company dealing heavily with the petroleum and agricultural chemicals industries here and abroad, its initial need, it feels, is ability to communicate in metric terms.

Thus, for Phase I, it is making a soft conversion with all its standards and specifications maintained on an inch basis but also expressed, in parenthesis, in metric equivalent dimensions or values. The second step, five years away, will be to turn the emphasis away from inch and to metric, showing metric as the primary measurement and inch dimensions or values in the secondary role. The designs at that point may or may not be to metric modules.

At Phase III, the customary units will be eliminated entirely and, presupposing a U.S. national conversion is taking place and has progressed sufficiently, designs then would be in metric modules.

Among other companies now metricating, several different approaches are being taken with respect to their product designs and manufacturing facilities.

International Harvester began at one largely self-sufficient division where the product designers and manufacturing men are in close proximity and in one

location. General Motors used Fisher Body Division as one of its early guinea pigs to determine the difficulty of conversion. Warner & Swasey's Cleveland Turning Machine Division and Addressograph-Multigraph Corp. each conducted a pilot exercise with a particular product to see exactly what a "hard" conversion would entail at the design and manufacturing levels and to get firm estimates on the cost penalties for metric materials and insight into the supplier difficulties they would encounter. Clark Equipment Co., Eaton Corp., and Ingersoll-Rand Co. are designing new products in metric modules but making soft conversions of existing products for international customers.

Ford Motor Co., with extensive metric experience overseas and in a Tractor Division that manufactures and sources worldwide, concentrated its early domestic work at its Lima (O.) Engine Plant, with the basic engine for the Pinto and Mustang II as the point for gaining hands-on metrication experience.

Initially, Ford's Engine Division developed a metric orientation program for its management personnel and its product design and process engineers. Then, to assure that the pertinent activities—product design, manufacturing, and purchasing—would be working with the same parameters, the company's Product Engineering Office prepared a metric system manual.

Among the design parameters set forth in the manual are: design in metric modules, use the millimetre regardless of the dimension's magnitude, retain third angle projection (rather than the European first angle), and adopt dual-dimensioning (with metric measurements in the primary position and decimal-inch sizes on an attached computer-run printout, a technique originated by Caterpillar Tractor Co.).

Interestingly, Ford at first used only metric dimensions with no inch equivalents on its drawing as a way of forcing "thinking in metric," but abandoned this practice as time went on.

Both Ford and GM indicate that they have had fewer problems than they had expected. Edward J. Janis, GM's staff project engineer for the Metric Planning Activity, says that the conversion also is going faster than was anticipated.

GM began dual-dimensioning on its product drawings (a la Caterpillar, Ford) but has since gone strictly to metric. "The difficulties (with this) to date have been minimal and experience has been excellent," Janis says, adding that among GM personnel and suppliers the metric-dimensioned drawings are proving not to be a stumbling block. Fisher Body has converted its new body programs to the European practice of using body grid squares of 100mm rather than the former 5-in. grids.

Both companies have found no need as yet for mass conversion of machine tools. "In most cases," says Janis, "we have found our existing inch equipment is capable of producing metric parts and does so with no problems at all." He adds, however, that "it would be premature to say that a large amount of machine conversion will or will not occur."

**Some Key Questions for the Metrication Decision**

**I. TIMING**

- What are our competitors doing?
- What are our customers doing?
- Are we trying to develop more export business?
- Will metrication cost us more/less later?

**II. PLANNING**

- Is someone responsible for collecting and organizing information so our company can make its decision rationally?
- Should we now have a metrication study committee?
- Are we participating in standards-making organizations?
- Do we make long-range product design plans? Are metric designs being considered?
- Are we considering metric or dual-capability equipment in our long-range capital investment plans?
- Can we make metric conversion economically advantageous? By reducing product mix? By replacing obsolete equipment? By sourcing on a worldwide basis?

**III. IMPLEMENTING**

- Will we make a "soft" or a "hard" conversion?
- How long will our conversion take?
- What measurement-sensitive equipment will need to be converted/replaced?
- What will be our policy with respect to employee-owned tools, gages?
- Do we need outside help in employee training?
- How will we service old products built to inch sizes?

"There are many ways to convert machine tools," he indicates. These range from "a piece of tape with new markings that go around a (hand wheel) dial, to gear reduction and conversion dials on the lead screws of the machines, and digital readouts which—with a flip of the switch—allow readout in either metric or customary units."

At Ford-Lima, most of the equipment used on the 2.3-litre-displacement engine is of the transfer machine type and was built entirely to inch dimensions. At a given station on a machine, the only area that may be directly affected by metrication is the drill size and its bushing and collet.

In grinding equipment, wheels are purchased in inch dimensions; the wheel dressing attachments are built to metric dimensions. Milling keyways, which normally required special-size cutters, now is done with metric-size tools. Gears are hobbed with metric cutters, but since only the diameter and tooth form need to be in metrics, the arbor uses a customary measurement.

In assembly and testing equipment, the equipment is in customary dimensions with only the compo-

nents that contact the metric product in metric dimensions. Torque is now expressed in newton-metres, but most of the checks are performed automatically or with "go-no go"-type equipment so no direct operator involvement with the measuring method is required.

To avoid mixups of metric tools, gages, fasteners, and the like with similar items in customary dimensions, the metric products are color-coded (in the case of gages) or stamped "M" (in the case of fasteners and tools). Metric engine production facilities in the plant are totally separated from those making inch-based engines. At assembly plants, where fastener mixups could more easily happen, the Pinto/Mustang II metric fasteners are color-dyed.

## III. THE MATTER OF TIMING

Lacking a national decision, it is easy for a company to avoid the detailed consideration necessary to make a rational decision with respect to a metric conversion or continued adherence to the status quo. Many companies, thus, believe they can face the question during the 12 to 18 months that a National Metrication Board or some similar governmental agency would take to plan a coordinated national approach—assuming that metric legislation ultimately becomes law and such a board is established by that law.

Everyone close to the metric conversion picture admits the necessity for such a coordinated program—the disruptions possible through one industrial/commercial/public sector of the economy getting too far ahead or behind the others would be chaotic. A perhaps typically American response to this need—when Congress failed to enact metric legislation—was ANSI's creation of the American National Metric Council, which, on a voluntary, nongovernment-sponsored basis, became organized to do much of the spade work that a governmental board would have had to do, with the major exception of carrying on a pro-metric propaganda campaign.

M.W. Kellogg Co. says the timing guideline for a company in the absence of a government program is: "(1) When it is convenient or profitable for your company or your industry; (2) when your customers demand it; (3) when your suppliers force it."

Among the conversion examples above, there are ones that fall into Categories 1 and 2. None, as yet, has been brought about through nonavailability of inch-based supplies, unless such items as spark plugs, photographic materials, pharmaceuticals, and similar products that have long been metricated are involved. And all companies now converting feel they must stay on the dual system of measurement for a very extended period to service products that were built to customary measurements.

The United States will not be predominantly metric by 1980 as many ardent metric proponents a few years ago had wished. But the country's industries by that time will clearly be on a two-measuring-system basis, with the inch phasing out.

This fact is one more input that a company doing any market and production planning for five years ahead must factor into its decision-making process. Avoidance of consideration of the metric question today is effectively a decision to hold your products to the customary system for several years into the future.

Will Kellogg's Category 3 be the external factor that forces the decision upon you? ■

# USEFUL LITERATURE

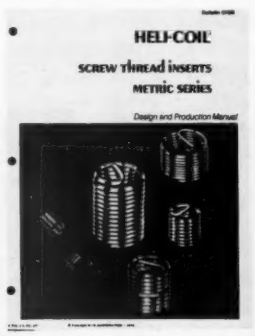
**Details on thread standards,** thread engagements, hole sizes, and torquing requirements **for metric thread-**

**forming screws** are presented in an 8-page brochure from **Camcar Screw & Mfg.** *Indicate No. 777 on card.* For a 12-page pocket size brochure **"Metric Conversion** of Threaded Fasteners," *indicate No. 778 on card.*

**A 4-page brochure by Esna Division** describes its Hex series of **metric thread stop**

**nuts** with red nylon locking collars. Included is a comparison chart of inch/metric diameter/pitch combinations. *Indicate No. 779 on card*

**The metric series of its screw thread inserts** is described in a 30-page design and production manual which also illus-




trates the retention principle. **(Heli-Coil Products)** *Indicate No. 780 on card*

**"The cost of metrication** can be, to a great extent, blended into the normal cost of doing business." Thus, in a paper on planning for metrication, Joseph Kochhan, Brown & Sharpe, puts down some of the frequently mentioned complexities of conversion. He explains a two-step approach to metrication that includes some advice on both the time and the procedures you might follow. *Indicate No. 785 on card*

# The Ingersoll-Rand Approach to Assembly Productivity

## ASSEMBLY CAPABILITY AT INGERSOLL-RAND: APPROACH TO ASSEMBLY PRODUCTIVITY —IT COMES IN ALL SHAPES, SIZES AND TYPES.

BY: J. McPhail, Marketing Manager, Automatic Production Systems

With the rapid growth of productivity-enhancing automatic assembly in the U.S. and abroad, Ingersoll-Rand starts this new year with proven assembly systems of every major type—synchronous and nonsynchronous transfer lines, as well as indexing and continuous-motion rotary table machines.

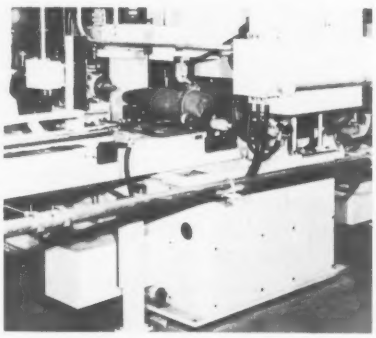
In the Ingersoll-Rand nonsynchronous transfer system shown in (Photo #1) 155 mm artillery shells are safely and efficiently assembled in an arsenal operated by a contractor on behalf of the U.S. Army.

This unit (Photo #2) contains a rotary table machine to assemble water pumps at the largest and newest automotive engine plant in the world — the Ford Pinto plant at Lima, Ohio. In addition to this machine, Ingersoll-Rand designed, built and installed 32 machines to feed, assemble and inspect critical fasteners in the engine's final assembly operation.

Two other Ford-Lima units are shown here (Photo #3), undergoing final inspection at APS. In addition to electronic torque assurance (TAS) on all torquing operations, this line contains the two latest innovations for assurance of proper installation torque coupled with 100% inspection for variables which adversely affect joint clamping force. These two new techniques developed by Ingersoll-Rand are called "Torque-Time" and "Torque-Turn." These innovations incorporate the measurement of elapsed time or angular rotation of the fastener from a given threshold torque and comparison of these readings to establish quality limits. This provides manufacturers with the highest level of fastener quality assurance obtainable today under production conditions.

This close-up view (Photo #4) shows a bearing-pressing operation at Buick Motor Division's Gear and Axle Plant where I-R's Automatic Production Systems Group had full responsibility for a 45-station, 350 ft.-long differential assembly system. Whether it's a single hand-held unit or a total assembly system, Ingersoll-Rand Automatic Production Systems has the expertise to provide equipment to exact specifications to help solve your assembly problems.

The latest advance in Torque Programming (Photo #5) by I-R is the DMC200 Micro Computer. This production line data acquisition system can be interfaced with the I-R Torque Assurance System (TAS) or Torque Control and Assurance System (Dial-A-TAS). It is a dedicated micro computer designed specifically for torquing operations. The DMC supplies "exception data" when a fastener fails to meet programmed torque requirements. "On demand" and "end of shift" data are also available on instant printout. Unit incorporates reliable MSI and LSI solid-state circuitry with plug-in modules.



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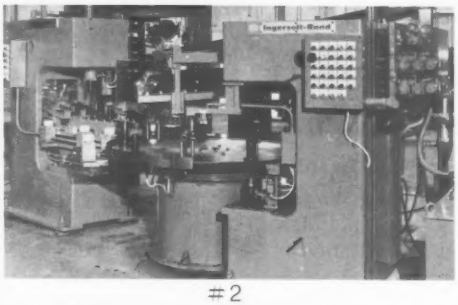

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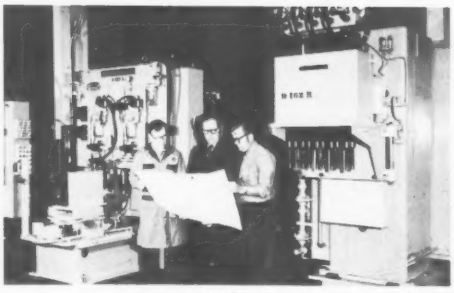

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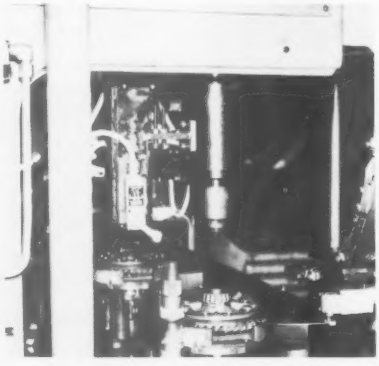

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#5



INDICATE NO. 211 ON BUSINESS REPLY CARD

# ASSEMBLY: Where Dollars Search for Breakthroughs

**Capital spending for assembly equipment is now second to that for metalcutting. Two newcomers: laser welding and ultraprecise torque control are featured here**

Although industry spokesmen say they will make sizable cuts in their capital spending this year, they also say they will only nibble at their spending for assembly equipment and supplies.

Investment in assembly equipment this year will be off only 14.6 percent from 1974 versus an average cut in capital spending of nearly 25 percent (see p. 24).

In our annual capital spending survey, the participants were asked: "Which of the following are you actively investigating for cost reduction?" Direct labor got mentioned by 75.6 percent of the respondents, 62.8 percent checked material, 45.5 percent checked assembly, material handling got 37.7 percent mentions, 48.1 noted in-process inventory, and 5.7 percent checked "other."

The interesting thing to note is that, with the possible exception of material, investment in better assembly methods can bring savings in all of the other listed facets of manufacturing.

Furthermore, the survey provides information on which industries regard assembly changes among their top needs. The makers of electronic components and accessories will spend 38.3 percent of their total capital investment this year on assembly equipment and supplies. With makers of communications equipment, 31.3 percent of the dollars will go for assembly; and more than 25 percent of the investment dollars by makers of business machines will buy assembly equipment.

In short, assembly operations increasingly are areas where improvements offer the return on investment good enough to justify expenditures, even today when dollars are hard to get for nearly any investment.

What will the investment go for? In many cases, it will be for more automatic assembly machines and equipment. In other cases, it will go to solve an OSHA problem ("smokeless" welding guns, for example).

And in other instances, it will buy equipment that represents breakthroughs in technology. In this article, two are discussed: laser welding and torque control.

**Big Potential in Laser Welding.** "I'm confident that production laser welding of metals will be common just five or six years from now." That's the opinion of Jeffrey P. Carstens, manager, high-power laser applications, United Aircraft Research Laboratories, East Hartford, Conn.

He feels laser welding "offers the benefits of electron beam welding without some of the limitations.

"In laser welding, you are working with a finely focused coherent in-phase beam of light. Typically, our systems run from 2 to 8 kw in power output, and we can focus that into a spot that's on the order of .020 in. in diameter. So this is putting 8 kw onto the head of a pin. That's a much finer spot than can be achieved with any other technique except electron beam . . . and we are not concerned about a vacuum."

James Mitchell, welding development manager, Manufacturing Development Office, Manufacturing Staff, Ford Motor Co., Dearborn, Mich., agrees that laser welding has promise. "The advantages are those of electron beam welding . . . sound welds with a very narrow heat-affected zone. We're focusing to a spot only .035-in. diameter on our experimental sheet welder to produce dust- and water-tight continuous welds.

"In addition to the fact that we do not need the vacuum chamber there are some further advantages. Even with out-of-vacuum EB welding, the nozzle is usually within about ⅜ in. of the workpiece. Our last focusing mirror is 22 in. from the work. Finally, since laser welding is not dependent on high-voltage for its travel, there is no need to protect operators from X-ray radiation."

As for applications for laser welding, Mitchell comments: "We are looking at many applications for laser welding. Probably the most spectacular one to the outsider is the welding of the Torino underbody panels." (Photo, p. 40)

"In this case, the lower back panel, rear floor pan, and the firewall are all put into the fixture. Each part overlaps the one adjacent to it. A high percentage of the material is rimmed steel about .035 in. thick.

"The laser can make a weld of this kind at traverse rates of 400 to

450 in. a minute. The laser power output is running between 6 and 7 kw.

"The laser was built by Hamilton Standard Division, United Aircraft Corp., Windsor Locks, Conn. That company, in turn, contracted with Gilman Engineering & Mfg. Co. (Janesville, Wis.), a division of Giddings & Lewis Inc., to build the machine. It is a five-axis machine, controlled by a PDP-14 programmable controller. The X axis is the table, the Y axis is travel of the laser gun across the gantry, the Z axis is vertical motion of the head on the gantry, and there are two axes of rotation on the laser head itself.

"The laser machine was purchased by the Automotive Assembly Division and is still an experimental machine with considerable development work planned before putting it into production. We still have a lot to learn about making such welds. One, for example, is that of fitup tolerances of the parts to be joined. Where there is no metal-to-metal contact, there will be a questionable weld.

"With the laser we do not have integral pressure, as we do with resistance welding, so we are working on ways to assure continuous contact of the two or more parts to be joined along the weld line."

Mitchell sees the potential of the laser extending far beyond that application, furthermore. "Another field for lasers in our industry is in a multitude of transmission parts, where EB welding has made some strides. A good example would be the torque converter and cover weld. We now MIG weld this. It is a pressure-type joint. The parts are half-round stampings that are pressed together and then welded. The laser would seem to be ideal for this. In addition, there may be laser welds on the carrier, replacing the present EB welds.

"I think that the dozen or so parts now being EB welded will all be evaluated for laser," he reports.

**This laser welder is joining four Torino underbody panels at traverse rates up to 450 in. a minute. So far the work is experimental, but Ford spokesmen predict several applications for laser welding in high production . . . notably some jobs that are now being done with electron beam. A United Aircraft spokesman foresees laser welding as "common just five or six years from now."**

**Plate Welding, Too.** On additional potential applications, United Aircraft's Carstens says: "With our current power densities, we can make penetrations to .060 in. at speeds up to 500 ipm in low carbon steel. We also have welded material that's about .008 in. thick at speeds of about 2000 ipm.

"In addition to the welding of sheet and foil, we are learning about the laser welding of plate. This work may have potential for shipbuilding, our first project. But it may also have potential for heavy construction equipment and farm machinery, and for pipeline welding, as well as others. We have, for example, demonstrated that we can make 'T' section welds, using the keyhole weld method, between ⅜-in. plate and a thicker base plate. In these applications, we often will make a weld pass from both sides of the joint."

**One Laser, Multiple Work Stations.** "A further advantage of the laser for welding is that, as with some arc welding, a single source can supply power to multiple work stations. The light beam from the laser is focused and directed by optics and mirrors.

"With computer control of those elements, the laser can make a weld in one position, and when that operation is finished, the beam can be directed and focused on another station. As a matter of fact, the second, third, and fourth stations could use the laser for welding, machining, or heat treating—the light beam may be the same for all of the operations. Only the time (and the use of a gas to blow out the molten metal in the case of machining) would vary. Full utilization of the laser at its full output power is actually an advantage, since it avoids transient operating conditions.

"The distance such light can travel can range up to several

**The Joint Control System, introduced by Standard Pressed Steel Co., senses both torque and angle of rotation to detect when the fastener has begun to yield. This, says the company, assures that the bolt is under tension, and that there is a positive clamping force on the joint**

**A microprocessor monitors the spindles (as many as 65) in a torque system from Chicago Pneumatic Tool Co. Its signal can be used for a variety of outputs including a printout of torque**

hundred feet. The greater the distance, the larger the focusing optics, but that's a small price to pay."

As for laser life, Carstens explains: "We have cathodes that have run for more than 1000 hours and they look just like new ones. The gas in the tube glows and pumps the laser beam. There is no wear, no moving parts. The life of a laser source is theoretically limitless."

About the cost of laser welding, Ford's Mitchell opines: "Although the initial cost of the equipment is high, the operating cost seems to be low."

**How Tight Is Right?** Precise control of fastener torque is another area where developments are coming thick and fast.

"Torque is really an imperfect way of measuring clamping force, and it is the clamping force that the user is really interested in —measuring the twisting force is an indirect way of getting at what the user really wants to know." This was the opinion Robert J. Seccombe, manager of Ingersoll-Rand's Automatic Production Systems Division, Farmington, Mich., expressed in PRODUCTION in March 1973. It is still his opinion.

And because the last five years have seen more developments in recording, controlling, and assuring torque than in decades preceding them, users are becoming less satisfied with the conditions they've previously lived with.

**Who Cares and Why?** Standard Pressed Steel Co. offers the latest entry in the field of high-performance torquing. Stanley K. Smith, product manager, Special Products Division, explains: "Wherever there are critical joints, the manufacturer will be increasingly interested in the torque, or the clamping force. These include a joint at which failure might endanger human life, and joints where the warranty problem through difficult field servicing may be more costly than proper assembly."

His division has just introduced its Joint Control System, and Smith sees good markets in automotive, appliance, farm equipment, and construction machinery applications, and in other internal combustion engine uses, including outboard motors.

"On one engine that uses aluminum connecting rods with steel bolts, we feel if we can assure proper clamping force, we can trim the safety margin engineers have felt necessary, permitting use of smaller bolts. That means a reduction of mass on a fast-moving part . . . better performance at less cost," he notes.

It is known that Caterpillar Tractor Co. is interested in closer control of clamping force on the bolts that hold grouser plates to the track links, that International Harvester engineers are evaluating their needs on steering linkages,

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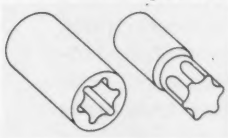

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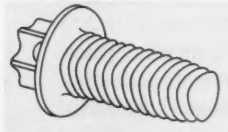

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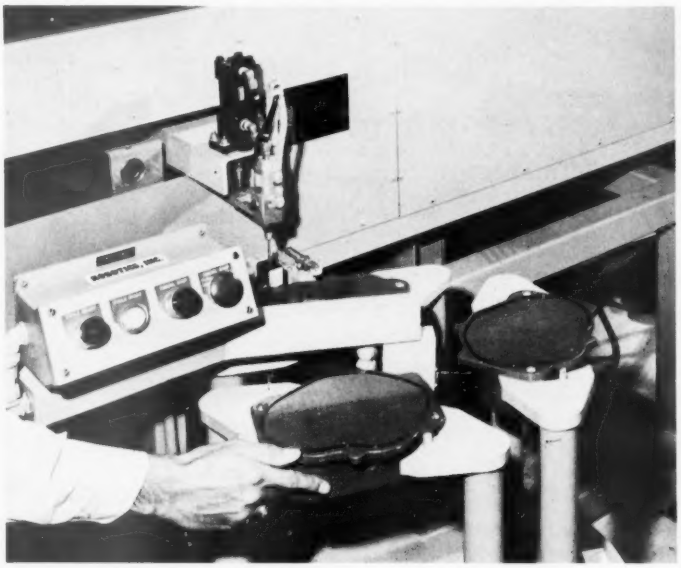

**Cork gaskets have not gone the way of the buggy whip, but silicone formed-in-place gaskets are making strong gains in high production. On this machine, built by Robotics, Inc., Ballston Lake, N.Y., Dow Corning's Silastic 732 adhesive/sealant will be applied to automotive transmission housings at Borg-Warner Corp.'s Warner Gear Division, Muncie, Ind. Production rates will be about 450 parts an hour. The machine is cam-controlled and uses an ITE Imperial "No Fault 48" programmable controller. Expected benefits include a cost saving of about 5 cents on cork's cost against silicone's 2 cents, saving in gasket inventory costs, and a better seal since the fluid fills any voids or pores**

and that both John Deere Co. and White Farm Equipment Co. have study programs under way. All of the automakers also have torque control programs both in production and in the works.

**A Plethora of Processes.** The state of the art in assuring torque or clamping force has developed so rapidly that, in the opinion of one authority, customers are still low on the learning curve. Here is a look at some of the alternatives they have to pick from:

At the first level is simply a high-performance motor, usually air. It cuts off precisely at the preset torque, every time. Variance can be under 25 percent, says one expert. Several years ago, Ford Motor Co. engineers came up with performance standards for "certified air motors"; and for critical jobs, the standards are used by other companies. Most makers supply such certified motors. This system is probably adequate for most "non-critical" joints.

The next step up is use of sensors on the spindle to measure the torque that has been applied, and then produce a warning signal when the torque is outside the limits prescribed. This is by far the most common method of checking critical joints; it manages by exception, no signal—no problem.

The next step up is typified by the Computork computer-based torque verification system of Systems Division (Madison Heights, Mich.), Chicago Pneumatic Tool Co. This is still a monitoring system, but much more capability exists to use the signaled information.

Lloyd Prestgard, division sales manager, says: "Eight transducers around each spindle send signals to a microprocessor built by Process Computer Systems, Inc., Flint, Mich. As many as 65 spindles can be monitored simultaneously and compared against previously established standards of both torque and time. The signals can be used to operate indicating lights, or to divert and identify rejects. Or they can be coupled with a Teletype to print out the reading on every spindle, or, on demand, to print out the last 10 readings on every spindle, or, on demand, to give a shift-end report that tells the number of cycles for each spindle and the number of good and bad assemblies.

"The system also can be tied to a host computer for additional data accumulation and analysis."

This system is now being used in both the farm machinery and construction equipment industries.

The next step is to add the control function to the monitoring. John F. Nickey, product manager, Industrial Power Tools, Gardner-Denver Co., Grand Haven, Mich., explains that his company's approach is to use a "downshift" air motor coupled with control.

"The spindle uses a high speed to approach the clamping point, then shifts into a lower speed so we approach the optimum torque-point (the stall-point for the motor) at an extremely slow rate. This can be done using the motor alone, or with monitoring, or by using the monitoring signals themselves to control the final torque," he explains.

Some authorities report that by using electronic sensing and control to trigger the cutoff, the torque spread can be cut in half. Most power-torque equipment suppliers offer at least the preceding range of alternatives.

**Closing In on the Ultimate.** Some users, however, are asking the equipment supplying industry for even more precision and con-

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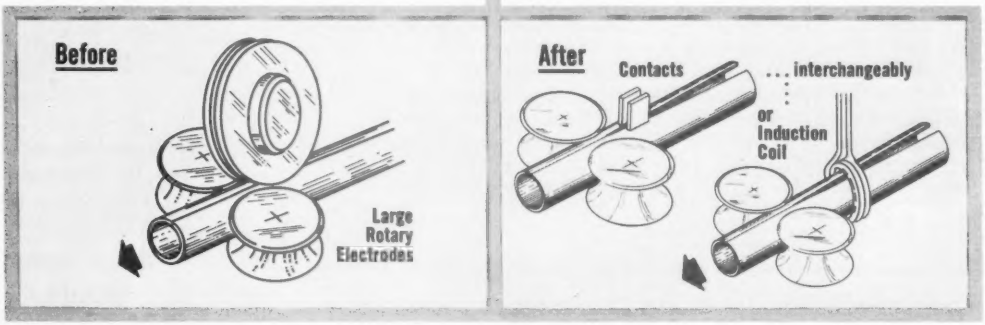


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**Three different degrees of torque control are used on this line that assembles the Ford 2.3 litre Mustang II engine at Lima, O. The equipment was furnished by the Automatic Production Systems Division, Ingersoll-Rand. On the most critical joints, bolts are run down to tight, then rotated a preset number of degrees to assure bolt stretch and clamping force**

sistency. As reported in PRODUCTION, October 1973, for example, Ford went at least two steps further at its Lima (Ohio) engine plant where the Mustang II 2.3-litre engine is being built. Ingersoll-Rand's "Torque/Time" and "Torque/Turn" approaches are used.

Torque/Time is explained by E. E. Rice, I-R divisional manager of engineering, in these words: "The fastener is first run through its free travel until it firmly engages the assembly. The initial increase in torque triggers the threshold level circuit and starts the time sequence." The second increase in torque represents an overstressed condition.

The two times must be determined through experimentation. Some point between them represents the proper allowance for threading. If the thread fit is tight, chips are in the hole, the hole is not tapped to depth, etc., the minimum allowable torque will be reached before the proper time has elapsed.

"For a fastener to be accepted, the torque rise from the threshold level must reach the acceptable torque level in a time period greater than T1 but less than T2. In other words, an 'accept window' is created between the end of the time periods T1 and T2 at the acceptable torque level."

If the maximum acceptable torque occurs later than has been predetermined, probably because of thread interference, the part also is faulty. In this system, the monitor senses both maximum and minimum torque and maximum and minimum time. If the cycle stops in that "window," the assembly is good.

At the Assemblex Show last year, a similar approach was shown by Thor Power Tool Co., a subsidiary of Stewart-Warner Corp.; and Standard Pressed Steel Co., one of the country's largest special-fastener makers, launched its first entry in the equipment business, the Joint Control System.

Frank Hayn, manufacturing manager, SPS' Special Products Division, explains the system simply: "With the Joint Control System, we tighten to the point of yield, then stop."

Each torquing spindle has its own sensors and controls, as in the others. These sense torque and angle (spindle speed). As long as the fastener is running in freely, nothing happens. However, when the fastener seats, the spindle stops. (In a multiple-fastener assembly, all spindles would stop at this point to assure no distortion of a cap or plate.) The spindle then turns slowly.

"During this rotation," Hayn explains, "the torque and the angle is monitored on each fastener. The instant there is a change in the relationship between the two, it means the fastener has begun to yield, the joint is clamped tight, the bolt is under tension, and rotation stops. Each spindle works independently."

SPS feels that this system allows for fastener variations and will provide a maximum number of good assemblies, or will signal if the optimum conditions cannot be met.

Ingersoll-Rand's Torque/Turn system also is designed to take the fastener beyond the yield point to assure that bolt tension is exerting a clamping force. As applied at Ford-Lima and in at least one other auto division, this system also has a separate set of sensors and controls for each spindle. Fasteners are run down to the snug point, and the spindles then turn the fasteners an additional predetermined number of degrees, setting up a precalculated stretch or clamping force.

**Total Assurance—The Users' Goal.** Despite the seeming quantum jump from the torque wrench that suppliers are giving key users, their basic desire is for assurance that the assembly is good.

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assembly is good . . . a must for warranty and liability purposes.

3. Possible savings by being able to go to a smaller bolt, since large safety margins may no longer be needed.

**There's Much More.** Obviously, all of the dollars spent on assembly equipment won't go for those two new developments.

Much of the money will go for more automation. Automatic assembly and subassembly projects are continuing, even in the depressed automotive industry. And in the electrical and electronic industries, where the assembly share of the dollars spent is high, automation is also high.

For example, at Robertshaw Controls Co.'s Fulton Sylphon Division, a diaphragm switch consists of two components: a ¾-in. diameter stainless steel adaptor and a ⅛-in. diameter copper tube, 1⅜ in. long. The switch is used in automotive air conditioners. The production rate was 500 an hour on a two-station shuttle-type brazing machine. Now, with a 108-station brazing machine, worked out with Handy & Harman engineers, the production rate is 2200 an hour, partly due to the automation, and partly due to a different flux ideal for automatic application.

Another example: A $200,000 investment in special assembly machines has permitted the production of 20,000 low-profile keyboard switches per shift at Switch Division of OAK Industries, Inc., Crystal Lake, Ill. That capacity can be boosted 300 percent, and defective parts and incomplete assemblies are ejected automatically.

In all automatic assembly, in-process testing or gaging is becoming more common.

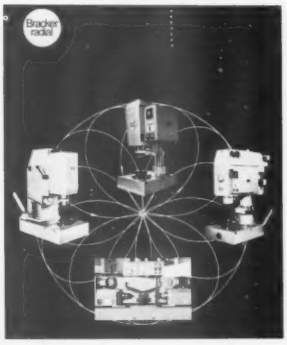
Adhesives continue to make inroads into metalworking, slowed at least in part by lack of understanding on the part of users. Many still don't trust "glue." There is little doubt about their ability to take loads (GM ran a car with the ring gears fastened to rear axles 10 years ago), but problems with application and field service have been barriers. Nevertheless, in industries such as appliance and automotive, adhesives are being used more and more.

"Hot melt adhesives have helped from the standpoint of automatic assembly," says Richard H. Blair, project manager, New Products Division, Eastman Chemical Corp. "Since you melt it at the point of contact, the normal adhesive handling problems are eliminated. We feel the appliance, canmaking, automotive, and other industries are our targets. We are now, for example, seeing it used for attaching skins to trucks. Our current limits at room temperature are about 1500 lb tensile strength and 40 lb peel. We can substantially enlarge the potential when we develop ways to avoid the preheating of the metal."

In summary, better use of fasteners, including more standardization, more use of automation, better control-monitoring-documentation, and the search for breakthroughs represent an intense effort on the part of many companies to trim their cost sails for 1975 and beyond. ■

# USEFUL LITERATURE

A 6-page brochure describing the Bracker **radial riveting machine** which employs a

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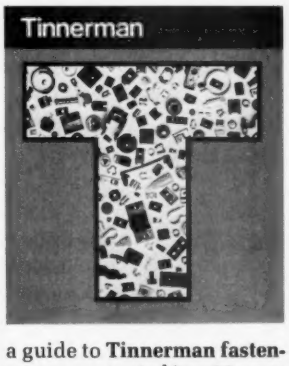
A 36-page catalog presenting comprehensive information on its full line of **quick-operating industrial fasteners** is offered by **Simmons Fastener Corp.** *Indicate No. 424 on card.*

Five publications are offered by **Union Carbide Corp.** For "The **Electron Beam Welding** of Common Engineering Materials," 10 pages, *indicate No. 429 on card.* For 24-page **"How to do TIG (Heliarc) Welding,"** *indicate No. 430 on card.* For 16-page **"Materials for Submerged Arc Welding** of Carbon and Low-Alloy Steels," *indicate No. 431 on card.* For 8-page **"Three-Wire Submerged-Arc Welding** of Line Pipe" *indicate No. 432 on card.* The **problems** most frequently encountered **in production resistance welding, and their solutions,** are presented in a 4-page brochure by **Robotron Corp.** *Indicate No. 433 on card.*

The principles of Speed Nut **spring tension fastening** and




a guide to **Tinnerman fasteners** are presented in a 36-page catalog offered by **Eaton Corp.** *Indicate No. 426 on card.* For Eaton's 22-page **industrial fastener general**

# USEFUL LITERATURE

**catalog,** *indicate No. 427 on card.*

A 4-page brochure describing **electron beam welding,** what it is, and its use as a design engineering tool is offered by **Schaevitz Engineering.** *Indicate No. 438 on card.*

A 4-page catalog on **self-locking fasteners** is offered by **Long-Lok Fasteners Corp.** *Indicate No. 444 on card.*

A 26-page bulletin covering design and application information for **copper brazing and bright annealing** is offered by **Brazing & Metal Treating, Inc.** *Indicate No. 428 on card.*

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Four publications are offered by **National Adhesives:** For a 12-page **guide to Bondmaster adhesives** and sealants for

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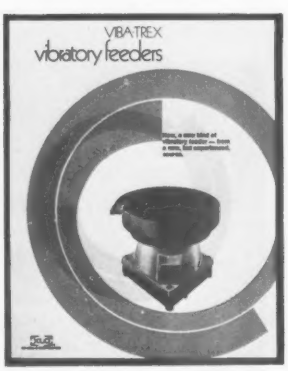


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plete Sturdilite line of **industrial and technical work stations** is offered by **Angle Steel Division of Kewaunee Scientific Equipment.**
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**Printed circuit board soldering machines** with models and options to meet virtually any requirements are described in an 8-page brochure by **Dee Electric Co.**
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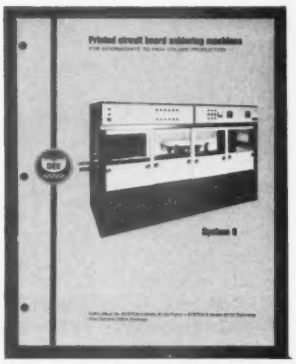
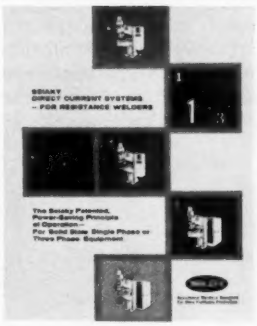


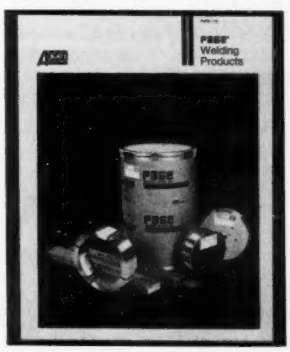
An 8-page welding brochure entitled **"The Why, The What, The How of Pulsed TIG"** is offered by **Airco Welding Products.** *Indicate No. 447 on card.* Also offered is a 32-page pocket size brochure describing **safe practices in welding and cutting.** *Indicate No. 448 on card.*

**Direct current systems for resistance welders** are described in a 16-page brochure by **Sciaky Bros., Inc.** *Indicate*



*No. 499 on card.* Also offered is a 6-page brochure describing **a high power laser system** as an advanced metalworking tool. *Indicate No. 443 on card.*

A 24-page brochure including descriptions and typical applications for the different




analyses of the **welding wire and rod** it supplies is offered by **Acco.**
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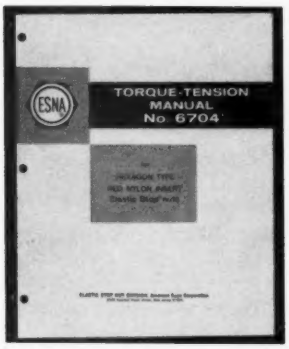
A 22-page manual presenting **torque-tension performance data for hexagon type** red




nylon insert Elastic **stop nuts** is offered by **Elastic Stop Nut Division.**
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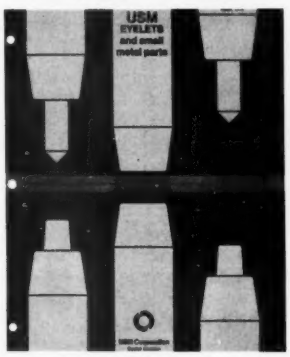
A 44-page catalog describing its full range of **eyelets, classified by type and applica-**




**tion,** and its eyeletting equipment, is offered by **USM Corp.**
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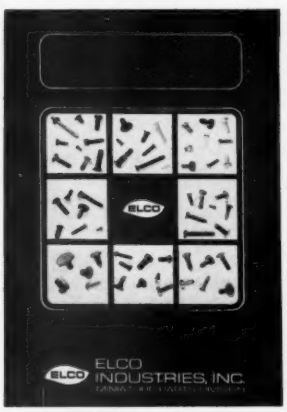
A 6-page brochure describing **the many capabilities of its**




**new Miniature Parts Division** is offered by **Elco Industries, Inc.**
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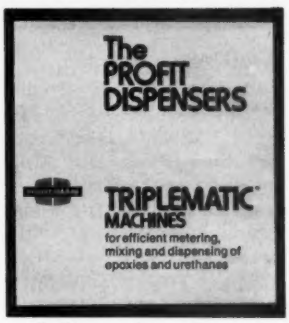
A file-folder containing data sheets on 13 **examples of dispensers and equipment for efficient metering, mixing,**




**and dispensing** of epoxies and urethanes is offered by **Hardman Triplematic Division.**
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A 4-page brochure describing its Model 607 **medium power laser** for industrial and

general-purpose laboratory applications is offered by **GTE Sylvania.**
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**Automatic pin inserting equipment** plus a varied line

# USEFUL LITERATURE

of fasteners, including Spirol pins, are described in a 16-page brochure by **CEM Co., Inc.** *Indicate No. 458 on card.* Also offered is a 4-page brochure describing **CEM headed Spirol pins.** *Indicate No. 559 on card.* For a 4-page brochure on CEM **self-tapping inserts and studs,** *indicate No. 460 on card.* And for a 4-page brochure on CEM **blind captive nuts,** *indicate No. 461 on card.*

A 30-page brochure entitled **"Arc Welding Stainless Steel"** and presenting the fundamentals of arc welding is offered by **Republic Steel.**

*Indicate No. 474 on card.* Also offered is a 34-page brochure **"Welding Stainless Steel"** describing factors affecting stainless steel weld quality. *Indicate No. 475 on card.*

Five pieces of technical literature relating to **welding** are offered by **Lincoln Electric Co.** For a 12-page brochure **"Fixtures and Manipulators** for Mechanized Arc Welding," *indicate No. 453 on card.* For a 20-page paper **"Distortion** . . . How to Minimize it With Sound Design Practices and Controlled Welding Procedures," *indicate No. 454 on card.* For a 20-page paper **"Assuring Weld Quality,"** *indicate No. 455 on card.* For a 4-page **"Designer's Guide** for Welded Construction," *indicate No. 456 on card.* For an 8-page "New **Stress Allowables Affect Weldment** Design," *indicate No. 457 on card.*

A 16-page booklet entitled **"Possibilities in Production Brazing"** is offered by **Handy & Harman.** *Indicate No. 462 on card.* Also offered is a 10-page brochure discussing brazing and **charting brazing alloys and fluxes.** *Indicate No. 463 on card.*

Two publications are offered by **Battelle-Columbus Laboratories.** For a 12-page paper **"Diffusion Bonding** of Specialty Structures," *indicate No. 464 on card.* For a 20-page paper **"Friction Welding** of Maraging Steels for Small Missile-Systems Applications," *indicate No. 465 on card.*

Specifications and dimensions for more than 260 stock and standard **high-speed precision index tables** and housed indexing mechanisms are presented in 50-page catalog offered by

**Ferguson Machine Co.** *Indicate No. 466 on card.* For a 6-page bulletin on Ferguson's smooth indexing **in-line transfer bases,** *indicate No. 467 on card.* For a 6-page brochure on **a mechanical, dual-motion parts handler** for automatic operations, *indicate No. 468 on card.*

Five bulletins describing assembly machines it has produced are offered by **Standard Tool & Manufacturing Co.** For the 18-page **"Dial Assembly Machine** for Components of Collapsible Steering Columns," *indicate No. 469 on card.* For the 12-page **"Palletized In-Line Transfer Assembly Machine** for Connecting Rod and Piston Assembly," *indicate No. 470 on card.* For the 24-page **"Pal-**

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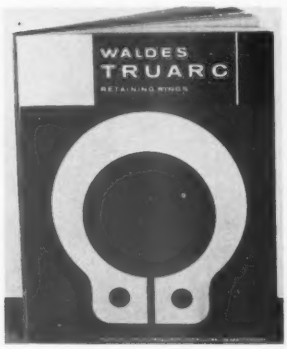
**letized In-Line Transfer Assembly Machine** for Disc Brake Assembly," *indicate No. 471 on card.* For the 20-page **"Nine-Station Dial Machine** for Assembling Ball, Nut, and Worm Assembly," *indicate No. 472 on card.* For the 14-page **"Ten-Station Dial Machine** for Assembling Piston, Connecting Rod, Wrist Pin, and Spirol Pin," *indicate No. 473 on card.*

A 128-page **technical manual** with engineering data and specifications for 50 different




types of **Truarc retaining rings** in over 850 standard sizes is offered by **Waldes Kohinoor, Inc.**
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**A wall chart that simplifies selection** of its cutting, welding, and heating equipment is offered by **Harris Calorific Co.**
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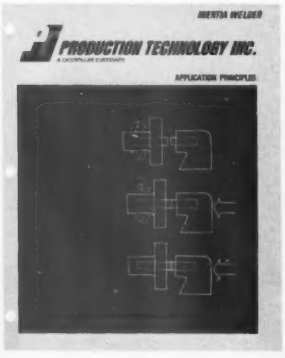
A 24-page brochure entitled **"Inertia Welder Application**




**Principles"** is offered by **Production Technology Inc.**
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A 4-page brochure introducing a new concept in **automa-**

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the newest concept in automatic and/or semi-automatic ASSEMBLY
Designed to provide total benefits of PRODUCTIVITY

**tic and semiautomatic assembly** is offered by **Assembly Machines Inc.**
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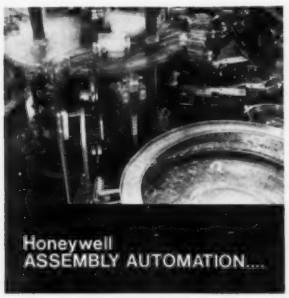
An 8-page bulletin describing its Stover line of **prevailing-torque locknuts is offered by Lamson & Ses-**

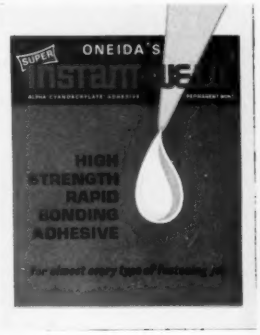
**sions.** *Indicate No. 478 on card.* Also offered is a 4-page brochure describing its **Spacnut which self-pierces and clinches.** *Indicate No. 479 on card.*

Three publications dealing with assembly are offered by **Honeywell:** For a 14-page brochure **"Honeywell Assembly Automation"** describing the building of as-




sembly and automation equipment at Honeywell, *indicate No. 480 on card.* For a 24-page paper entitled **"Automation in Assembly"** discussing product design for automation, *indicate No. 481 on card.* For a 20-page paper, **"Combining Automatic Inspection and Automatic Assembly,"** *indicate No. 482 on card.*

A 6-page brochure describing its **high-strength rapid bonding adhesive** for almost every




type of fastening job is offered by **Oneida Electronic Mfg. Inc.**
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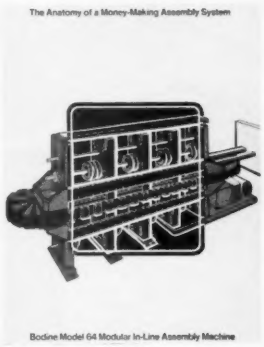
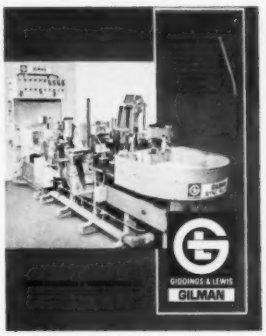
A 12-page brochure entitled **"The Anatomy of a Money-Making Assembly System"** is




offered by **Bodine Corp.** *Indicate No. 486 on card.* Also offered is a 32-page practical guide to **planning and tooling for automatic production and assembly.** *Indicate No. 500 on card.* For a 12-page brochure, **"Selective Automation** An Investment In Profit-Ability," *indicate No. 487 on card.*

How to get **the economy of standard design and the efficiency of a special machine** is




described in a 4-page brochure offered by **Gilman Engineering & Mfg. Co.**
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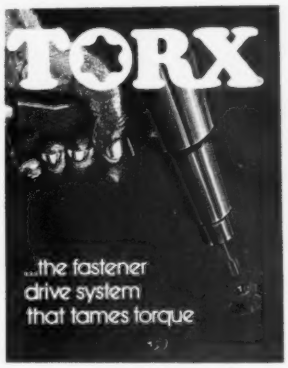
An 8-page brochure describing the **Torx fastener drive system** and the variety of




tools available is offered by **Camcar Screw & Mfg.**
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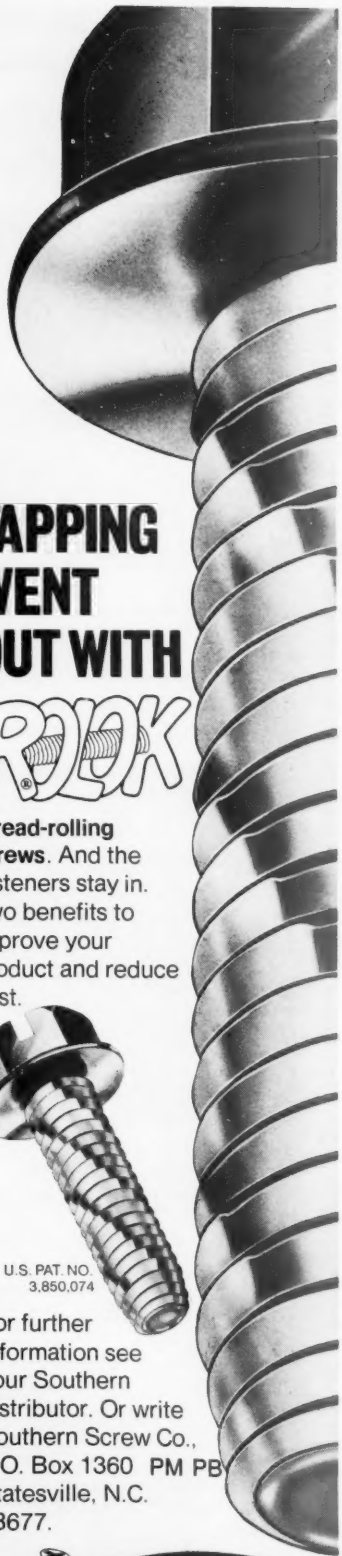
An 8-page brochure describing the **gas tungsten arc welding equipment and process** is offered by **Hobart**



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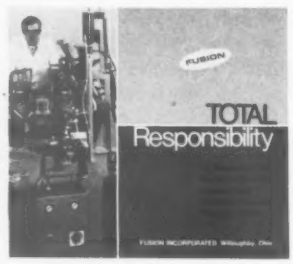
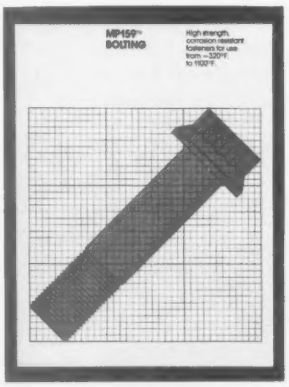
**Brothers Co.** *Indicate No. 490 on card.* Also offered is a 12-page paper on **"Automatic Programmed Tube or Pipe Welding".** *Indicate No. 491 on card.* For the 14-page technical bulletin **"Tube-To-Tube Sheet Welding,"** *indicate No. 492 on card.*

**Pastes, automatic applicators, and custom machines for automating brazing and soldering** operations are described in a 4-page brochure




by **Fusion Inc.** *Indicate No. 493 on card.* Also available is a 6-page reprinted article **"Increased Production through Brazing Automation."** *Indicate No. 494 on card.*

An 8-page booklet describing **fasteners made from a new Multiphase alloy** which is said to have the highest strength and creep resistance of any fastener material up to 1100 F is offered by **Standard**




**Pressed Steel.** *Indicate No. 495 on card.* For a 2-page technical article telling **how to lengthen fastener fatigue life,** *indicate No. 496 on card.* For a 4-page reprint **"Preventing Self-Loosening of Fasteners,"** *indicate No. 497 on card.* An 8-page brochure describing **heat detecting screws** providing reliable visual detection of overheating in critical components is also offered. *Indicate No. 498 on card.*

**Pre-coated bolts lock in place** and seal the threaded assembly. A four-page bulletin from Loctite Corp. shows how Dri-Loc can be used, and tells why. *Indicate No. 786 on card.* A four-page directory of Loctite applicator systems also is available. *Indicate No. 787 on card*

The Syncro-Trans **universal transfer device,** and how to program it for point-to-point operation, are described in a four-page brochure from ITT Industrial & Automation Systems. *Indicate No. 788 on card.* ITT's eight-page booklet on capabilities lists solutions to problems in **gaging, assembly, testing, and feeding and orienting.** *Indicate No. 789 on card.* Eight basic methods for **soldering printed circuit boards** are detailed in a 12-page book. *Indicate No. 790 on card.* A **selector for feeding and orienting** methods runs six pages. *Indicate No. 791 on card*

A 16-page, illustrated guide suggests **ways to select the right power screwdriver** for the job. It's from Atlas Copco. *Indicate No. 792 on card.* The company also offers a 12-page **guide for impact wrenches.** *Indicate No. 793 on card.* Information also is available on **nutrunners** *(No. 794),* **multiple nutrunners** *(No. 795),* **angle nutrunners** *(No. 796),* and **high-torque nutrunners** *(No. 797)*

Production of tube and pipe by high-frequency welding is described in an eight-page booklet from Thermatool. The process, equipment, and performance are discussed, as are applications. *Indicate No. 798 on card*

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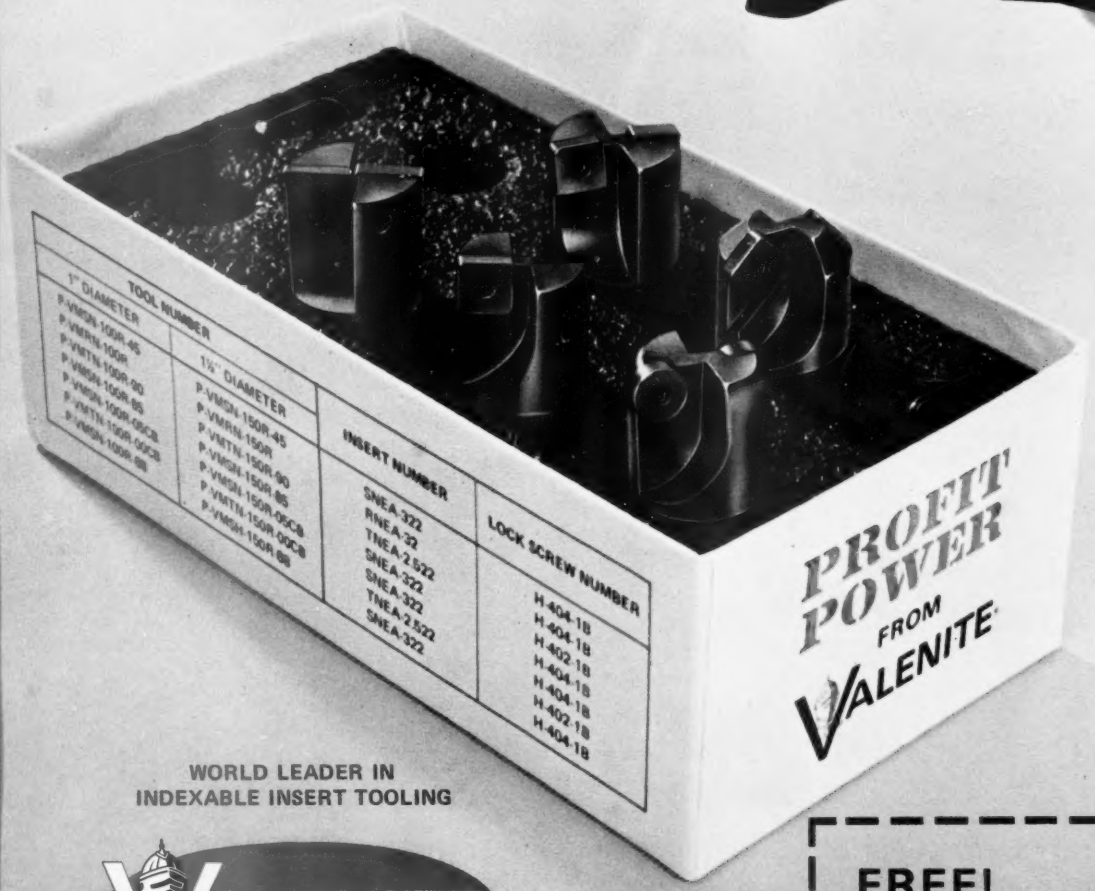
**The Valenite Profit Power Kit will help you whip the high cost of production; 7 cutters complete with inserts for only $230.00.**

You get 7 Valenite Mini-Mills---indexable carbide end mills that last up to 50 times longer than comparable HSS cutters.

The high performance cutters are designed specifically for low-horsepower vertical mills, such as Bridgeport, Langun, Index and Ex-Cell-O.

Valenite Mini-Mills can cut at 400 to 500 surface feet per minute in steel, more than four times faster than conventional HSS cutters.

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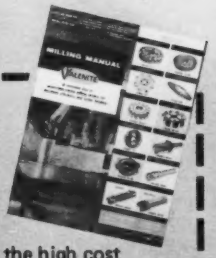


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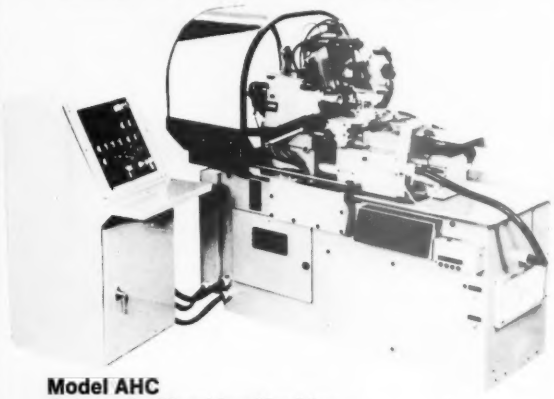


**Model AHC**
**Automatic Chucking Machine**

*Other Production Machines:*

Model HC-AT, High Speed Chucking Machine
Model DSM-A, Bar and Second Operation Automatic
Model DSM-59, Second Operation Machine
Model TFB-H, Turning, Facing, Boring Lathe
Model HSL-59, Precision Speed Lathe

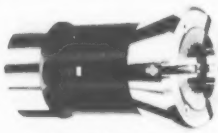
### *Super-Precision*
### TOOL ROOM MACHINES

**Model HLV-H**
**Precision Tool Room Lathe**

*Other Tool Room Machines:*

Model DV-59, Precision Lathe
Model UM, Universal Milling Machine

***Bulletins for all Production and all Tool Room machines available on request.***

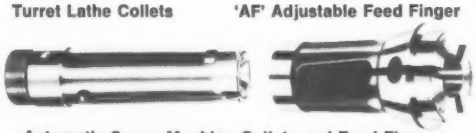


**Style "S" Master Collets and Pads**

**Style "B" Master Feed Fingers and Pads**

**Turret Lathe Collets**

**'AF' Adjustable Feed Finger**



**Automatic Screw Machine Collets and Feed Fingers.**
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**Collets for Lathes, Millers and Grinders.**
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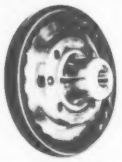
**Dead Length Collet, and Step Chuck**



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**Collet Index Fixtures**

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# HARDINGE

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# MACHINING: Total Job Planning

**Becoming familiar with raw materials and finished parts is first step in total job planning**

In looking at the planning function as it relates to machining, the manufacturing engineer needs to consider the parts he'll be processing, the volumes in which they're required, the machines and other equipment available and those additionally needed, the tools these parts will require, and countless other details.

He also needs to keep a sharp eye out for productivity-improving developments by equipment, tool, and materials suppliers so he can seize on such developments when they are applicable and advantageous.

In this section of the PLANBOOK, we're looking, first, at these new developments, then at the details of the manufacturing engineer's work as he considers a new part for high-volume machining and as he re-examines an existing low-volume part for a better manufacturing method.

## DEVELOPMENTS TO WATCH FOR

Machine control technology is advancing faster than any other technology in the industry. Thanks to continuing advancements in electronics development, machine control systems presently have more capability than ever, yet are simpler, more reliable, and more compact. Systems range from simple two-axis pegboard programmed controls to sophisticated computerized systems capable of controlling and/or monitoring several machines.

Machine design, on the other hand, seems to be advancing more slowly. There have been numerous innovations, particularly in regard to increasing horsepower and developing more efficient basic machine configurations. But most machine tool industry observers agree that other than the development of machining centers with automatic tool changers few truly significant improvements have been accomplished in recent years in the design of standard machine tools.

General Motors' Manufacturing Development Staff, as a consequence, is instigating several new concepts in this area. One of these is a high-performance bar machine with high-speed cutting capability of about 2000 sfm. Another is a chucking machine with dual level chucks that permit complete machining of the workpiece in a single chucking.

A third idea being explored involves the use of a segmented grinding wheel five times larger in diameter than normal, mounted on a multiple-station machine. The thought here is that the larger wheel will produce more than double the surface cutting speed without increasing centrifugal force to the point of causing segment failure.

A different approach to achieving grinding wheel surface speeds on the order of 25,000 sfm has been taken by Carnegie-Mellon University under the sponsorship of the

**Making heavier cuts at higher speeds can reduce cycle time. Here Valenite Loc-A-Dex holder and triangular insert cut 1040 steel at 350 sfm with .050 ipr feed and 1¼ in. depth of cut**

Grinding Wheel Institute.

In this departure from the conventional peripheral grinding wheel, the wheel is not molded but is made up of segments held in place by mechanical chucks. When conventional peripheral grinding wheels fail at high speeds it is usually because of centrifugally induced tensile stress. The new design circumvents this cause of failure because the segments are held together by compression rather than tension.

Both approaches are indicative of the great interest in increasing grinding productivity through higher speeds.

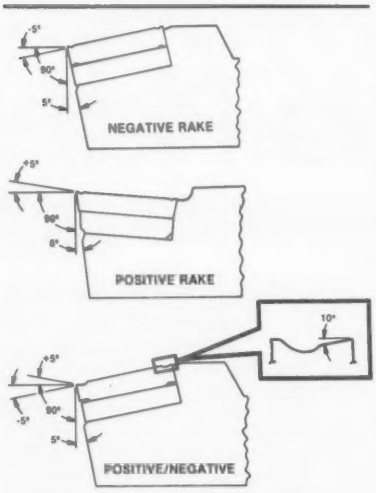
**Cutting Tool Developments.** Also interested in higher machining speeds are the cutting tool manufacturers. Carboloy's Dr. Elmore Kennedy, at the International Machine Tool Show last fall, told us that a major problem in trying to boost turning speeds is chucking.

"You can have a machine that can turn at 10,000 rpm, but you can't get a chuck capable of holding the part at that speed," he said.

Dr. Kennedy's remark cannot be argued since the size of the part was not defined; however, S-P Manufacturing Corp., Cleveland, O., has just introduced an item that helps establish chuck gripping force.

S-P maintains that force, per jaw, is the only accurate way to check the safety range of power chuck jaw gripping forces, and it has developed a gage that will fit most power chucks rated to a maximum of 25,000 lb per jaw. The company comments that periodic checks of chucks should be made, adding that poorly lubricated chucks will lose as much as 50 percent of their gripping force.

Generally speaking, cutting tool manufacturers are doing a great deal to improve machining productivity. In the past two years, most of the major carbide insert manufacturers have introduced positive-negative inserts that fit standard negative rake holders but




provide positive rake angle cutting action. The advantages are many, but the main user benefit is that these inserts provide twice as many cutting edges as the ordinary positive rake insert.

In the area of milling cutters, a number of new, more efficient designs have been introduced. Among these is a two-module face mill developed by Sandvik-Coromant and called the "Auto Cap."

This cutter is about three times lighter than a conventional cutter and takes about half as long to change because the cutter module is separate from the support module with a single screw joining the two.

Another feature of this design is a spring mechanism that provides quick and precise clamping and release of inserts during indexing.

Another recent design is Valenite's "Serra-Sine" milling cutter. This indexable insert milling cutter uses inserts with serrated cutting edges that are wedge-lock-mounted in the cutter body in a phased relationship.

Available in both end and face mill styles, these cutters are said to be capable of removing a ton of steel per hour.

At a demonstration of a "Serra-Sine" end mill during the IMTS 1974, a 20-hp Bohle milling machine was used to make a 2 in. deep cut in mild steel at 447 sfm. Feed was 7.9 in. per minute for a removal rate of 15.8 cu in. per minute.

New tool materials also are being introduced constantly. Carboloy, for instance, has introduced indexable inserts consisting of a .020 to .030 thick layer of cubic boron nitride bonded to a carbide substrate.

Known as Borazon CBN inserts, these new tools are said to be capable of metal removal rates up to 20 times that of carbide on the super alloys such as Inconel 718, Rene 41, and Astroloy.

Synthetic diamond compacts, too, have joined the ceramics and titanium and tungsten carbides as a high-performance cutting tool material for certain applications.

But most major tool manufacturing companies are heavily researching still another tool material—cermets. These metal-bonded ceramic cutting tools may well be the next major breakthrough in high-speed metal removing technology.

## NEW PART—HIGH VOLUME

It may have taken many months to move from the drawing board to the machine shop floor, but when a new product design is released to production, the moment of truth for the manufacturing engineers is at hand.

Usually, the new design already has been reviewed by everyone involved. Individually and collectively, the designers, metallurgists, experimental and testing people, value analysts, purchasing, quality control, production and material control personnel —and the manufacturing engineer—have scrutinized and analyzed, computed and disputed, cussed and discussed every detail of the project. Now success or failure rests on the manufacturing engineer and how well he has planned for this moment.

Within a few days, the results of his planning will be revealed by

how smoothly production begins, how quickly the initial production schedule is met, and how inexpensively the new product is produced in terms of labor cost, scrap and rework cost, and equipment amortization.

**Producibility Is First.** Before the manufacturing engineer can begin thinking of the equipment that will be needed to machine the component parts of the new product, he must familiarize himself with their every detail. He must know how each one functions and how it fits with the others at assembly. He must know what dimensions are critical. He must know the form and type of material and the envelope size of each component. Surface finish requirements, blind holes, ratio of hole depths to diameters, structural strengths and weaknesses, classes of threads required, maximum and minimum tolerances. He must know all these and know them well.

While the engineer is studying his prints of the finished parts, he should also be checking them against material specifications. If the part is to be machined from a casting or forging, he needs to know the location of parting lines, bosses, cored holes, etc. Since he is beginning to think of how these parts can be produced, he needs to know the approximate amount of metal that must be removed from each surface, and whether any preliminary operations such as qualifying or machining of locating surfaces or holes may be required.

In short, by thoroughly studying raw material prints and/or specifications, finished part prints, samples of forgings, castings, etc., and prototype parts, the manufacturing engineer is able to draw some conclusions as to the producibility of the part. These conclusions will influence all subsequent decisions in establishing the machining process.

**Machine Selection.** At this point, the manufacturing engineer already has determined that certain types of operations will be needed. Certain surfaces obviously can be milled. Others, because of tighter tolerances, may require broaching. A finish requirement on others may dictate grinding. And so on through drilling, tapping, boring, turning, etc.

But before the specific grinding, milling, boring, or other machine type can be selected, the manufacturing engineer must consider another factor: the volume of parts required.

In this regard, he should know the forecasted yearly volume. He should know the maximum volume requirement projected for the peak month of that year. And he should know of any peculiarities in scheduling plans that might have an effect on production requirements at any time during the year.

Without this information, he cannot determine machine capacity requirements correctly. With it, he can decide whether to use standard single-purpose machines or go the transfer machine route.

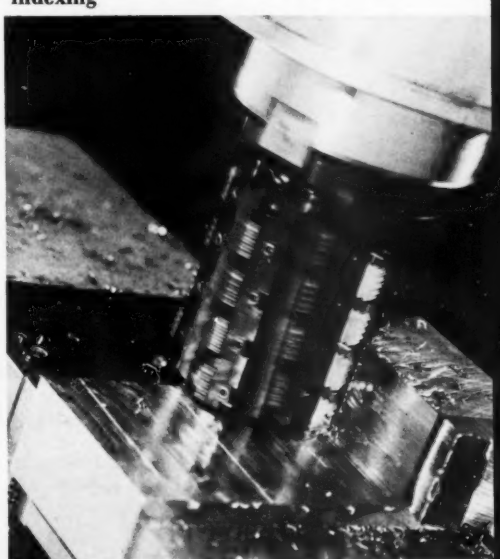
Several other factors, of course, will influence this decision. One of these is the availability of existing equipment that can be adapted to produce the new parts with minimum capital investment. Another is lead time: Is there enough time to obtain bids from machine builders, award a contract, then get delivery in time for debugging before start of production?

Other factors include labor costs, return on investment policy, floor area requirements, material handling equipment costs, utilities, maintenance costs, etc.

**Selection of Tooling.** Meanwhile, the manufacturing engineer will be thinking of the tooling to be needed. He knows the machinability characteristics of the materials; he knows the operations that will have to be performed and in what sequence; he has settled on certain areas of the part as being best to locate from. Now he must think of how the part can best be held, what tool materials and tool geometrics will be most efficient, and what gages will be needed to assure part quality.

While standard cutting tools often suffice for the majority of machining operations, almost invariably a special tool will be needed somewhere along the line. A special broach may be dictated

**Two-module face mill features spring mechanism for fast and easy insert indexing**

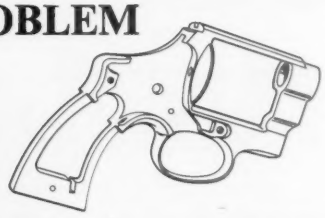


**Serrated inserts on this end mill make possible metal removal rates of nearly 16 cu in. per minute**

# New England Machine solves production milling problems

Over 600 New England standard and special precision machine tools have been designed and built to solve difficult production milling problems efficiently and economically. These machines are at work today milling components for business machines, pumps, farm machinery, compressors, firearms, electronic equipment and many other applications. Most of these machines apply new approaches to special problems in contour milling.

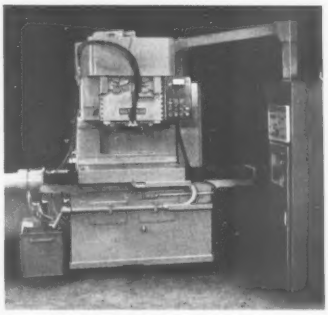
## PROBLEM



Contour mill outer periphery and inside trigger guard of forged steel revolver frames. High volume, fast changeover, mirror finish.

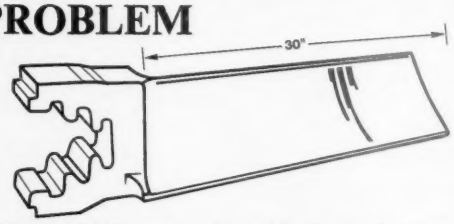
## SOLUTION

This standard New England Model 133 milling machine makes use of customer furnished tooling from an obsolete machine, produces two parts ready for polishing every eighty seconds. Three different shapes are produced merely by changing NC tapes.



Model 133 Standard Numerically Controlled Milling Machine

## PROBLEM




Mill the airfoil area and the platform of steam turbine blades, six-at-a-time, from bar stock or rough forgings.

## SOLUTION

A new design of Airfoil Milling Machine with separate tracers for airfoil and platform. This three-spindle machine costs less than half the price of competitive six-spindle machines and occupies one-quarter the floor space.

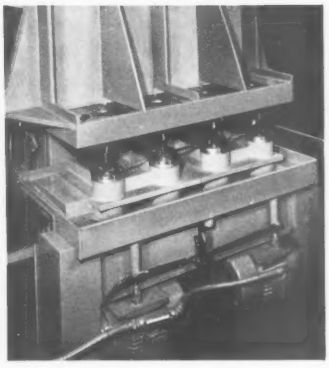
Model 140

## PROBLEM

Mill the mid-span struts of precision-forged titanium compressor blades, blending the root fillet with the forged airfoil surface. Customer's request was for two four-spindle machines with tracer control.

## SOLUTION

A single new numerically controlled machine with four inverted spindles and eight work stations. Tooling designed to force the blending surface into a pre-determined shape, in spite of forging variations. Load four parts while milling four. NC program mills specified strut shape and blends with airfoil. Production rate equal to two former four-spindle machines.



Model 143

## What is your milling problem?

From a vault full of standard designs and twenty-five years specialized experience, we can certainly make some practical recommendations. Let us review your prints and production requirements.

Manufactured in U.S.A. by:

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Cable address: NEMAT, Berlin, Conn.



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by the configuration of a particular part. Or a special milling cutter may be needed in order to combine two or more milling cuts and accomplish them in one pass.

Whatever the reason, when special tools are required, the manufacturing engineer must remember that these tools must be designed before they can be built. And, since they are perishable items, provision must be made to ensure an adequate supply on hand.

The same holds true for gages. Standard thread, plug, and ring gages are readily available as cataloged off-the-shelf items, but special "go-no go" depth gages, for example, require lead time.

Workholding devices are another matter. Many different standard chucks, collets, and expanding arbors are available for most turning operations, and magnetic chucks usually are already a part of many plane surface grinding machines. However, for most other high-volume machining operations, special workholding fixtures are usually the rule rather than the exception. Again, adequate lead time must be allowed to permit the fixture designer and subsequently the fixture builder to do their best work.

**Wringing Out Waste.** Some manufacturing engineers consider their task completed when the various operations, sequences, etc., have been determined and detailed process routings issued which show the machines, tools, and gages that are to be provided and used for each operation.

Working on the assumption that production performance on every new job automatically will be improved after it has been in the shop awhile, these engineers leave the task of making these improvements to the production foremen, job setters, and machine operators.

Where there are methods engineers, it's usually their job to go over the process routings and planned floor layouts before these changes are submitted for management approval. Using estimated floor-to-floor times established for each operation, these engineers can often discover ways to cut considerable fat from the process plan.

**Don't overlook standard cutting tools and workholding devices**

They may find, for instance, that one operator can run two machines instead of one if the floor layout is changed to bring the two machines front-to-front instead of back-to-back. They may suggest that a conveyor be relocated to make machine loading and unloading easier and faster. Or they may recommend that double fixturing be provided on certain operations so that loading and unloading can be done within the machining portion of the cycle.

But even where the manufacturing engineer has supporting methods engineers, he, himself, will want to question whether all the elements involved in every operation cannot be improved.

He should ask himself questions like these:

1. Can part loading and unloading be automated by mechanical means?
2. Can hydraulic clamps or other quick-acting devices be used?
3. Can locating pins be bullet-nosed for easier part-in-fixture locating?
4. Can fixture locating pads be relieved so that fixture cleaning can be minimized?
5. Can gaging be performed during the cutting portion of the machine cycle?
6. Can more than one machine be operated by one operator?
7. Can deburring be done by mechanical means (tumbling, vibratory finishing, electrochemical)?
8. Can indexable inserts be used instead of solid or brazed tools?
9. Can preset tools be used to speed tool changing?
10. Can setting blocks be used when making tool changes?
11. Can anything be done to reduce "air cutting " time?
12. Have all safety precautions been considered (guards, control switches, etc.)?

In brief, the manufacturing engineer should ask himself: Have I planned this job so well that maximum utilization of men, machines, materials, and floor area will be realized on "Day One" of production?

## ESTABLISHED PARTS—LOW VOLUME

In the foregoing we have highlighted some of the considerations of manufacturing engineers when planning for high-volume production of a new part. But new part designs and high-volume production are not the only concern of manufacturing engineers.

A look at the planning effort for the low-volume production of established parts is provided by examining the work done by Henry R. Graf, manager of manufacturing at AiResearch Manufacturing Co., Sepulveda, Calif., a Garrett Corp. division.

Graf's responsibility at the 1200-employee Sepulveda facility includes the manufacture of components for "transportation hardware." Included in this established line are auxiliary power units, heat transfer and cryogenic

(continued on page 65)

# General Electric's Full Line Mark

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General Electric's 550 line has what today's NC machine tool user is looking for:

**OUTSTANDING PERFORMANCE . . .** because each 550 is customized for a particular machine application.

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# Value Today

**WIDEST ACCEPTANCE...** worldwide over 100 machine builders now offer GE Mark Century 550 numerical controls with every type of machine tool.

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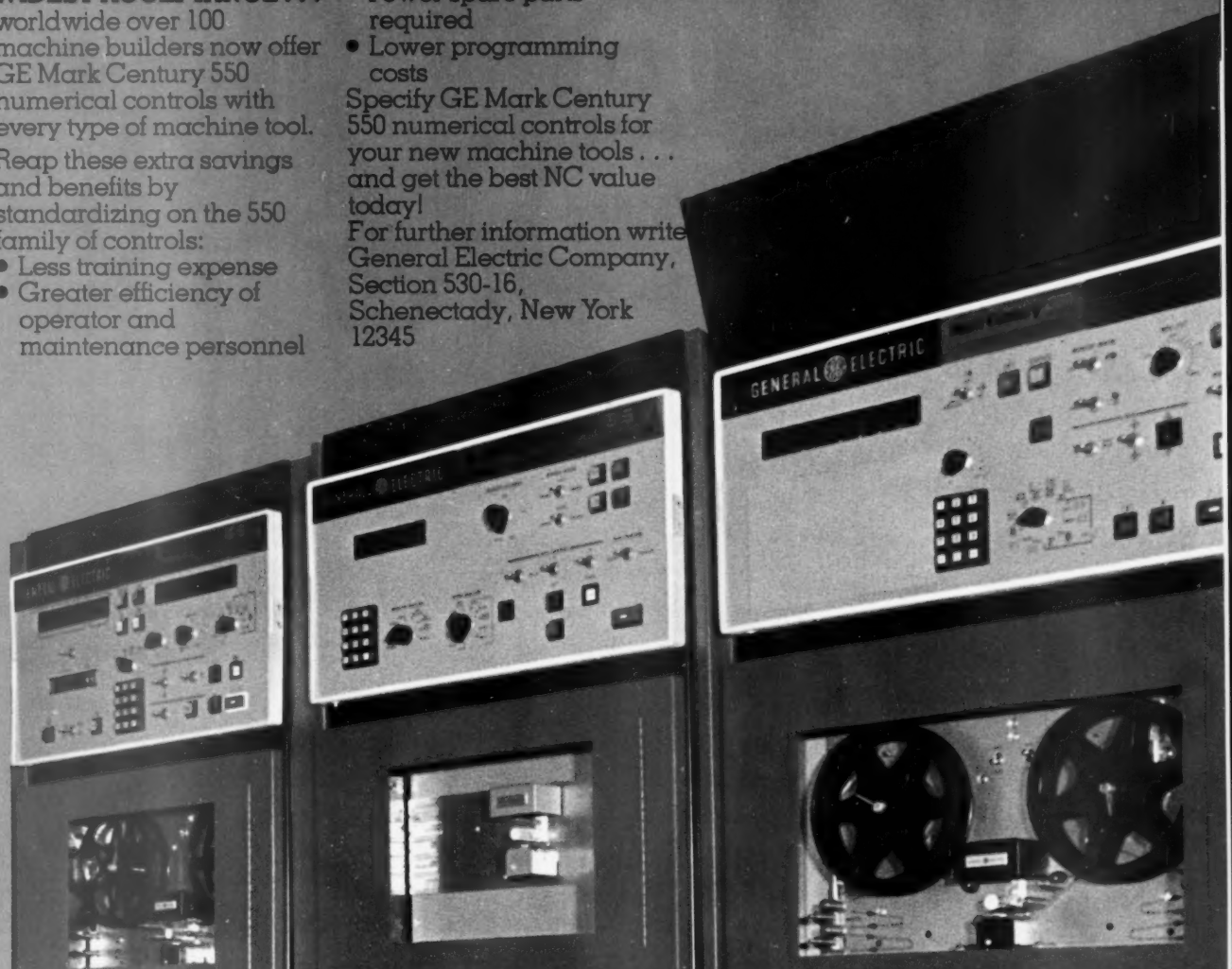


**550T** . . . Added feature control for 2-axis turning.

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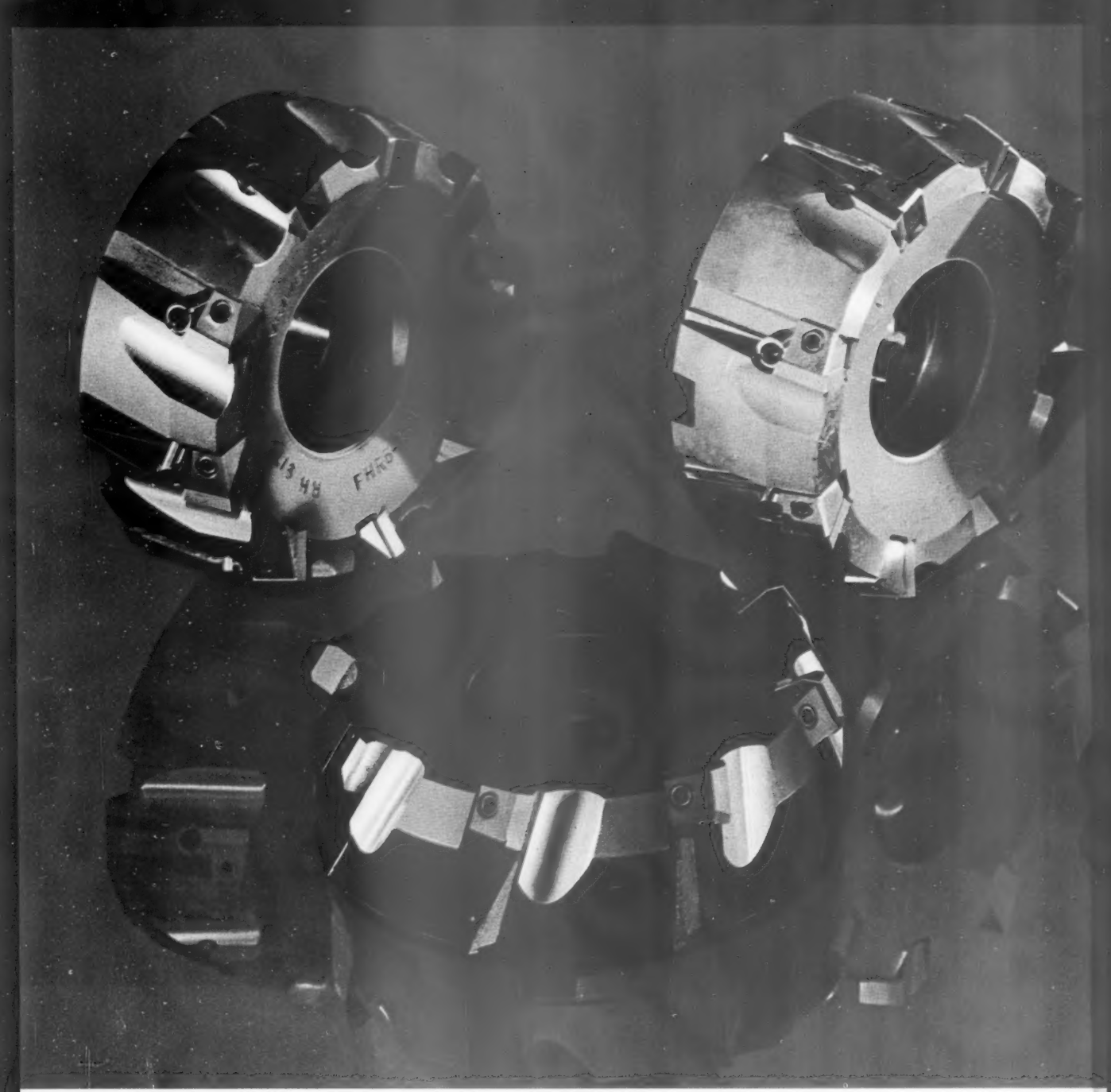

# We have a milling cutter system to meet your needs

Other cutting tool manufacturers might make that promise, but you want increased productivity not promises. With our expertise in milling cutter geometry and cutting tool technology, we can provide a practical, cost saving solution to your milling problems.

Your VR/Wesson representative shares your concern with cost and efficiency. He will help you select the VR/Wesson milling cutter system best suited to fit your specific needs . . . and you won't have to compromise your requirements. Whether it is conventional or N/C machining, we have the right milling cutter and cutting tool material to help increase productivity.

Let VR/Wesson's representative or distributor demonstrate the difference our milling cutter systems can make in meeting your needs. Call him or write.

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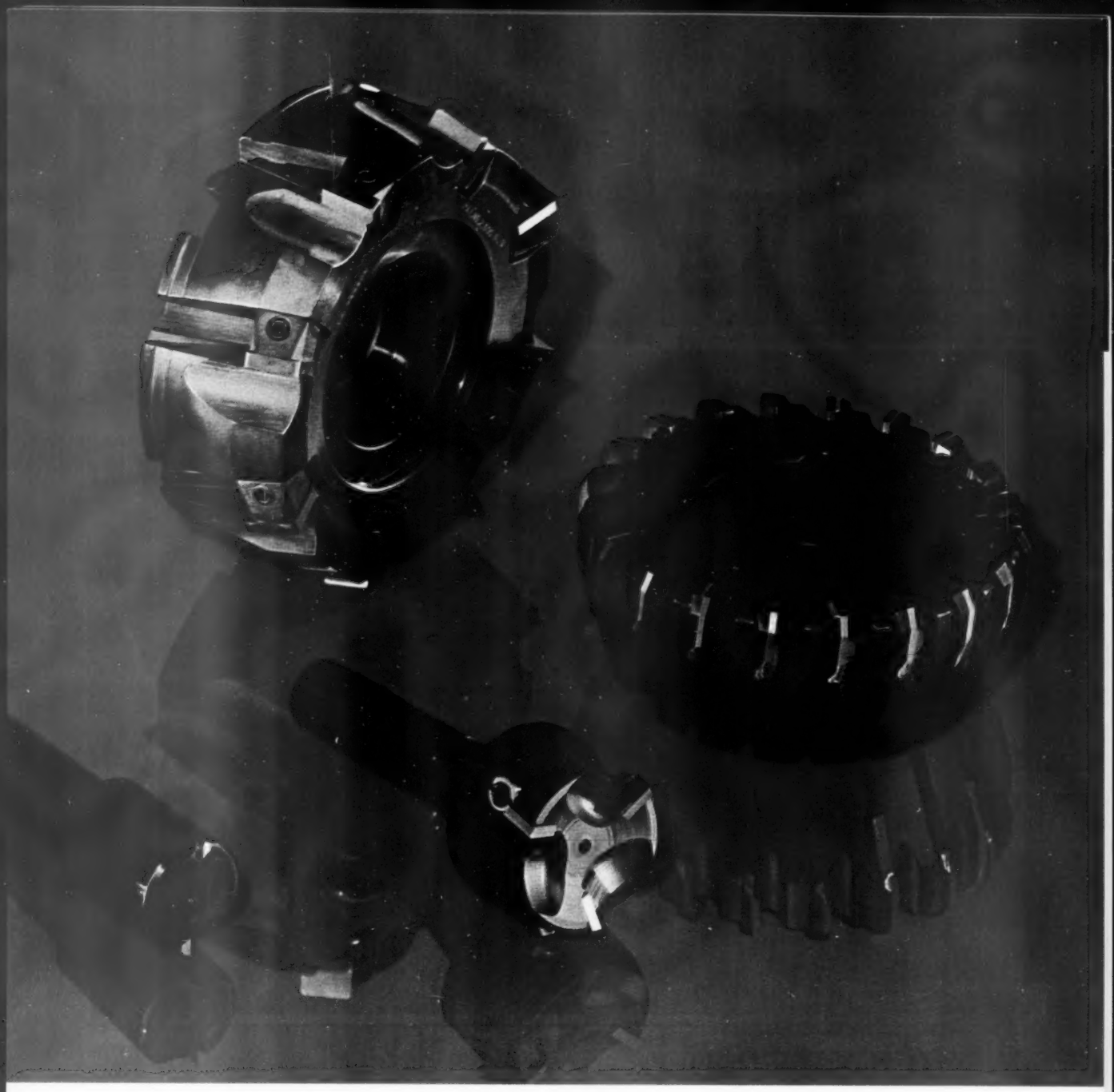

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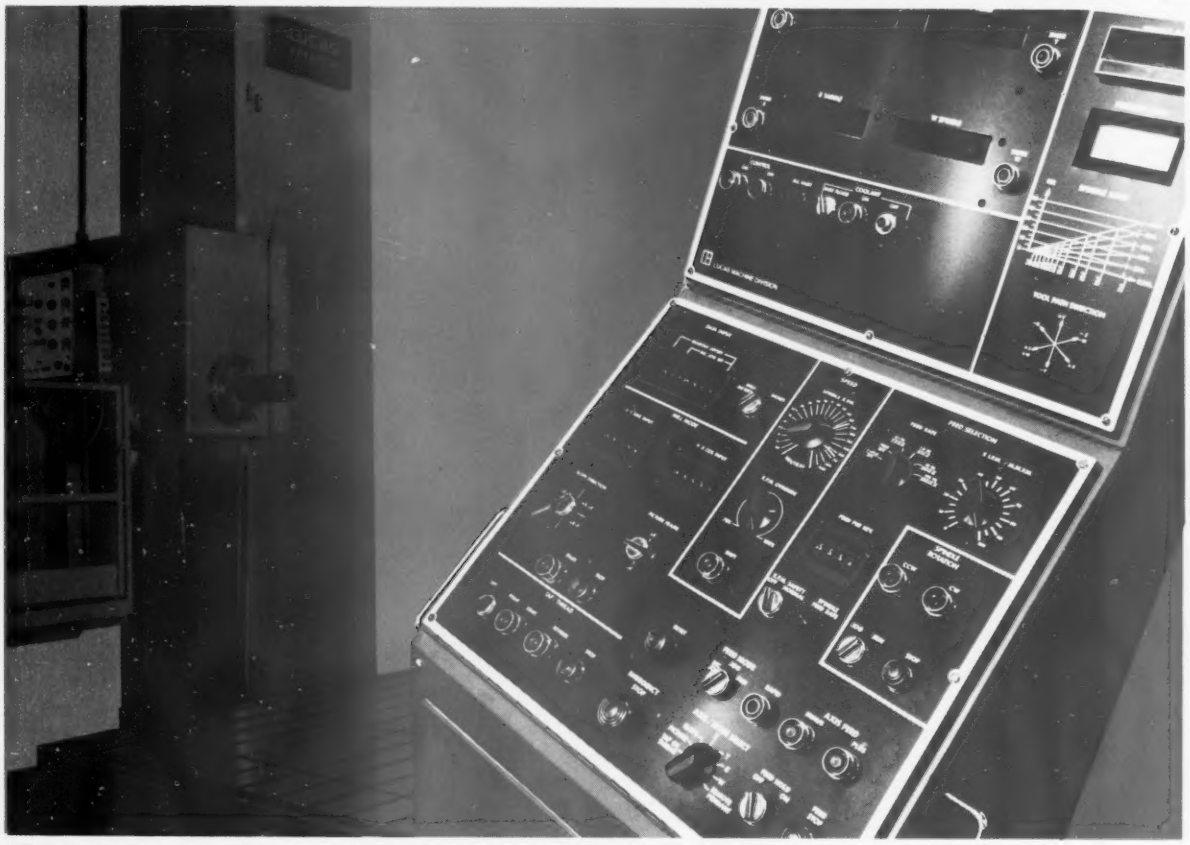

## New 9/10th System for Lucas horizontal boring mills

No tape or programming support required. Yet our new controller gives your Lucas HBM 9/10ths of the productivity of an NC machine. With it, you can position very accurately by manual data input, cut very accurate slopes, tap, even single-point thread. You get absolute readout display of 4-axes. You get infinitely variable spindle RPM. You get infinitely variable feed rates with inch-metric switchability. Our new digital solid-state controller is actually a feed rate generator, controlling the direct-coupled SCR-regulated DC drive motors. (Lucas has eliminated feed gear boxes.) It combines MDI with absolute position readout to give you a far more productive machine. Phone or write for more details.

*Exclusive Lucas-designed digital, solid-state controller for Lucas HBM's provides performance features previously available only on NC machines.*

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(continued from page 59)
systems, electro-mechanical systems, environmental control systems (air conditoners for DC-10 aircraft, for example), ground transportation hardware for mass transit systems, systems for military computers, aircraft power systems, and jet engines.

Using conventional single-purpose machines, production lot sizes have to exceed 100 pieces in order to amortize the considerable setup times involved. To provide more manufacturing flexibility, reduce setup time, and make smaller lot sizes feasible, AiResearch has turned to numerically controlled machines.

In a period of about a year and a half, four NC turning centers have been installed. All are Cincinnati Milacron universal models with eight OD tools and four ID tools, and all are equipped with Acramatic control consoles. Two are 54-in. models, one is a 72-in., and the other is a 100-in. model.

The results have been highly gratifying to Graf. "But," he says, "you just can't drop an NC machine on the plant floor and expect it to pay off. You have to get ready."

"Getting ready" for Graf involves a "team concept." He puts together a team made up of the machine operator, a planner, the programmer, and a tooling man, along with the supervisors involved.

With the team working together to produce the part in the most efficient and economical way possible, some of the traditional rivalries and friction between programmer and operator are eliminated. Ideas are accepted from anyone on the team both before the part gets to the production floor and after.

John A. Stiltz, tool engineer at AiResearch, brings out some other facets of "getting ready" for NC. "One of the reasons we stuck with Cincinnati," he says, "was because we wanted interchangeability of both tape and tooling."

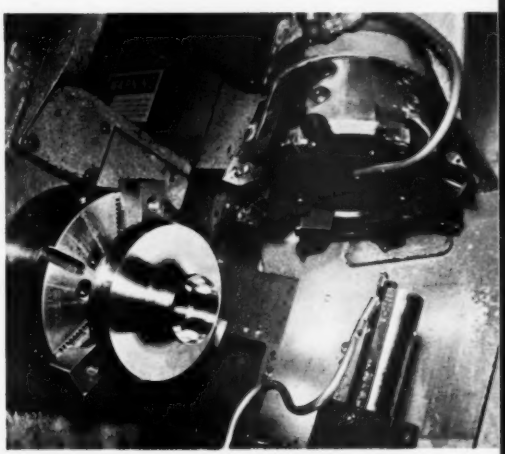
He notes that AiResearch is using computer-assisted programming for about 90 percent of the tapes; that the manufacturing group has direct access on a high-priority basis to the plant's IBM 370 computer; and that the group also has a private terminal, an IBM 2770, with all the needed peripherals—key punch, tape punch, reader, printer, and plotter.

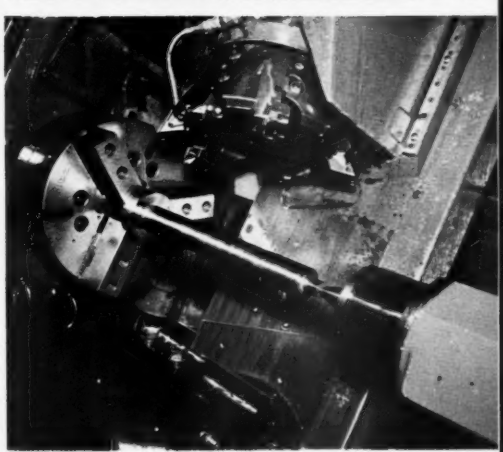
The programming department is using the Cinturn macro programming system provided by Cincinnati Milacron, but its own capability has enabled the department to expand on this method and add some routines to meet specific requirements.

The tape library runs to about 450-500 tapes with three or four new tapes a week coming into production. Average tape cost, according to Stiltz, is about $40 each.

**How the Planning Pays Off.** An example of the results of Graf's planning and subsequent execution of his plans to utilize NC is contained in the economies AiResearch has achieved in producing diffuser scrolls for air turbines.

The part is a 48-lb forging of Inconel 718 about a foot in diameter





**Planning for NC resulted in considerable savings in both cycle times and set-up on these parts**

### 10 MISTAKES TO AVOID

A number of major cutting tool manufacturers list the most common mistakes their customers make in ordering and using various cutting tools. Contributors to this composite list include: Kennametal, VR/Wesson, Sandvik Coromant, Niagara Cutter, and Greenfield Tap & Die.

1. Buying on basis of price rather than cost per unit produced.
2. Specifying close-tolerance inserts or special tools when standards can do the job more economically—and vice versa.
3. Failing to purchase sufficient backup tooling and/or to consider continuous availability.
4. Making specification errors, such as providing incomplete or incorrect catalog numbers and failing to specify grade of carbide or HSS.
5. Failing to consider complete range of carbide grades available including titanium coated, and ceramics.
6. Running tools at incorrect speeds and feed rates.
7. Running tools too long before changing for resharpening or indexing thus causing smashups, heat damage, and scrap parts.
8. Failing to properly apply correct lubricant or coolant.
9. Using utility holders on NC machines designed for qualified ± .003 in. holders.
10. Ignoring tool holder maintenance and handling of tools carelessly.

with a very complex shape. It formerly required eight operations on four conventional machines and took a total of 29.9 hours to set up. "We're doing them now in three operations on a turning center and one on a conventional machine," says Graf. "And we're down to a total of only 4.4 hours of setup time with more than half of that being required by the one set-up on the conventional machine."

On another part, a piston now being machined on a conventional automatic chucker and one of the NC turning centers, Graf reports that setup time has been reduced from 7 hours to 2½ hours. Additionally, cycle time has been reduced 4.0 hours for about a 2½ to 1 productivity increase.

# USEFUL LITERATURE

Five publications are offered by **DoAll Co.**: For a 16-page brochure on **special application tools,** including diamond-edge band tools and

spring-tempered blades, *indicate No. 501 on card.* For a 32-page pocket-size **"Guide To Wheel Selection"** listing abrasive products, *indicate No. 502 on card.* For a 48-page brochure discussing the design, manufacturing techniques, and quality controls that produce what is claimed to be **the world's finest end mills,** of which over 1800 styles and sizes are in stock, *indicate No. 503 on card.* For a 16-page brochure **"High Speed Steel Band Saw Blades,"** *indicate No. 504 on card.* For a 16-page brochure **"Carbon Steel Band Saw Blades,"** *indicate No. 505 on card.*

**A thermoplastic tooling compound** which is castable for stabilizing, supporting, and fixturing and **holding thin-wall, odd-shaped, and non-magnetic parts,** by pouring it in or around the parts, is described in a 6-page foldout

brochure by **Rigidax Division.**
*Indicate No. 506 on card.*

Four brochures relating to its machining centers are offered by **Kearney & Trecker:** For a 6-page foldout brochure describing its new numerically

controlled **multiple-spindle head indexer module,** *indicate No. 507 on card.* For a 12-page technical paper **"Why DNC?"** *indicate No. 508 on card.* For a 4-page brochure describing **a remote computerized diagnostic system** for its NC machining centers, *indicate No. 509 on card. For a 4-page brochure describing* **a computerized calibration system** for its MM200 machining centers, *indicate No. 510 on card.*

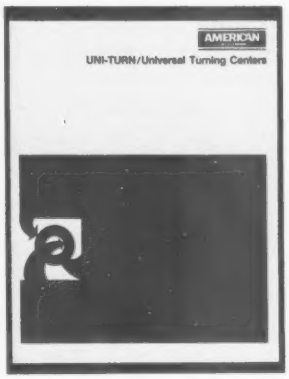
An 8-page brochure containing **capsule descriptions of more than 100 items of literature** available from its technical information center is offered by **Moore Special Tool Co., Inc.**
*Indicate No. 511 on card.*

Three publications dealing with cutting tools and gages are offered by **Pratt & Whitney:** For a 58-page catalog de-

scribing **regular and miscellaneous end mills,** *indicate No. 512 on card.* For a 110-page catalog describing its line of **precision tools and gages,** *indicate No. 513 on card.* For a comprehensive 400-page catalog describing its **complete line of cutting tools,** *indicate No. 514 on card.*

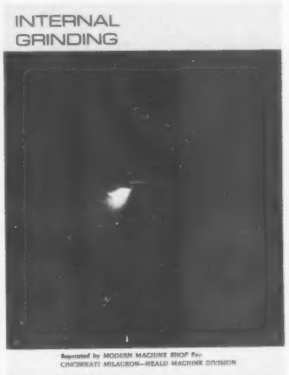
An 8-page, pocket size handbook, **"Guide for Safer Drilling,"** is offered by **General Chipbreaker Drill Co.** *Indicate No. 515 on card.* For **metric system drill conversion chart,** *indicate No. 516 on card.* For a 24-page catalog describing its **chipbreaker high speed steel twist drills,** *indicate No. 517 on card.*

Three brochures are available from **American Tool Inc.:** For a 12-page brochure describing its Uni-Turn **universal turning centers,** *indicate No.*




*518 on card.* For a 16-page brochure **"Panther Turning Centers, N/C & CNC,"** *indicate No. 519 on card.* For a 12-page brochure describing the American Hustler, a low-cost, **high-performance NC turning center,** *indicate No. 520 on card.*

A 40-page booklet containing a complete up-to-date compilation on the subject of **inter-**




**nal grinding** is offered by **Cincinnati Milacron.** *Indicate No. 526 on card.* For a 16-page booklet describing **multi-surface grinding,** such

Graf adds that he was able to eliminate a grinding operation and a deburring operation on the piston, and has reduced the amount of production time formerly spent on inspection from 10 percent to 2½ percent.

By accomplishing the objective of reducing setup time, AiResearch has been able to reduce lot sizes from the 100 or more range to an average of 35 to 50. Accompanying these smaller lot sizes, of course, are smaller inventories and lower inventory costs.

Summarizing, Graf says: "Our range of products, our great diversity of parts, and our need to respond quickly to changes, makes flexibility really important. And NC gives it to us." ■

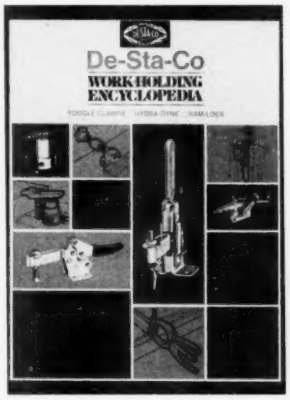
as bore and face, *indicate No. 527 on card.*

A 4-page bulletin describing its **carbide tipped single point tool bits** is offered by **Williams, United Greenfield Division.** *Indicate No. 528 on card.* Also offered is a 4-page brochure on Williams **setup tools and accessories.** *Indicate No. 529 on card.* For an 8-page bulletin describing Williams **turning tool holders,** *indicate No. 530 on card.*

Five bulletins containing engineering data and specifications are offered by **Madison Industries.** For a 14-page bulletin, **"Double Edged Boring and Finishing Tools,"** *indicate No. 531 on card.* For a 12-page bulletin describing **workholding systems** for cylindrical parts, *indicate No. 532 on card.* For a 20-page bulletin **on face drivers,** *indicate No. 533 on card.* For a 32-page bulletin on **roller burnishing tools,** *indicate No. 534 on card.* For a 12-page bulletin on **spade drills,** *indicate No. 535 on card.*

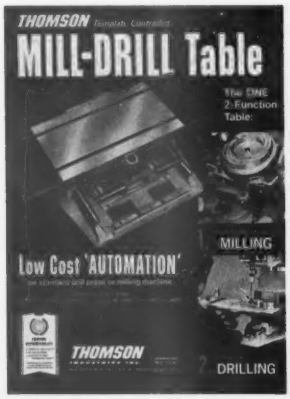
**Low-cost automation for drill presses** and milling machines is shown and described in a 14-page brochure offered by **Thompson Industries, Inc.**
*Indicate No. 536 on card.*

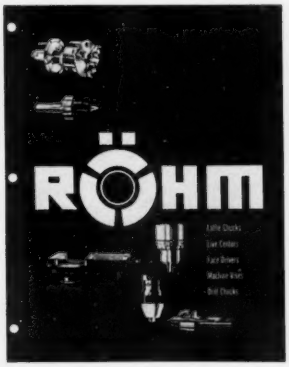
A 72-page **"Workholding Encyclopedia"** describing the use of toggle clamps in clamping, fixturing, and processing, as well as OEM applications, is offered by **De-Sta-Co Division.**
*Indicate No. 537 on card.*




**Automatic lathe-type cut-off machines,** bar feeders, and hot spinning machines are described in a 12-page brochure by **Modern Machine Tool Co.**
*Indicate No. 538 on card.*

A 30-page brochure describing **lathe chucks and manual and hydraulic vises** is offered by **Rohm Tool Corp.**
*Indicate No. 550 on card.*




A 12-page **"Primer on Taps"** intended as an elementary text for the tap user and buyer is offered by **Sossner Tap & Tool Corp.**
*Indicate No. 548 on card.*

**Kasto high production cold saws with automatic bar feed** are described in an 8-page brochure by **Charles E. Manning Co.**
*Indicate No. 549 on card.*

A 26-page brochure describing its line of **drilling and machining units** and components is offered by **Ferguson Machine Co.**
*Indicate No. 556 on card.*

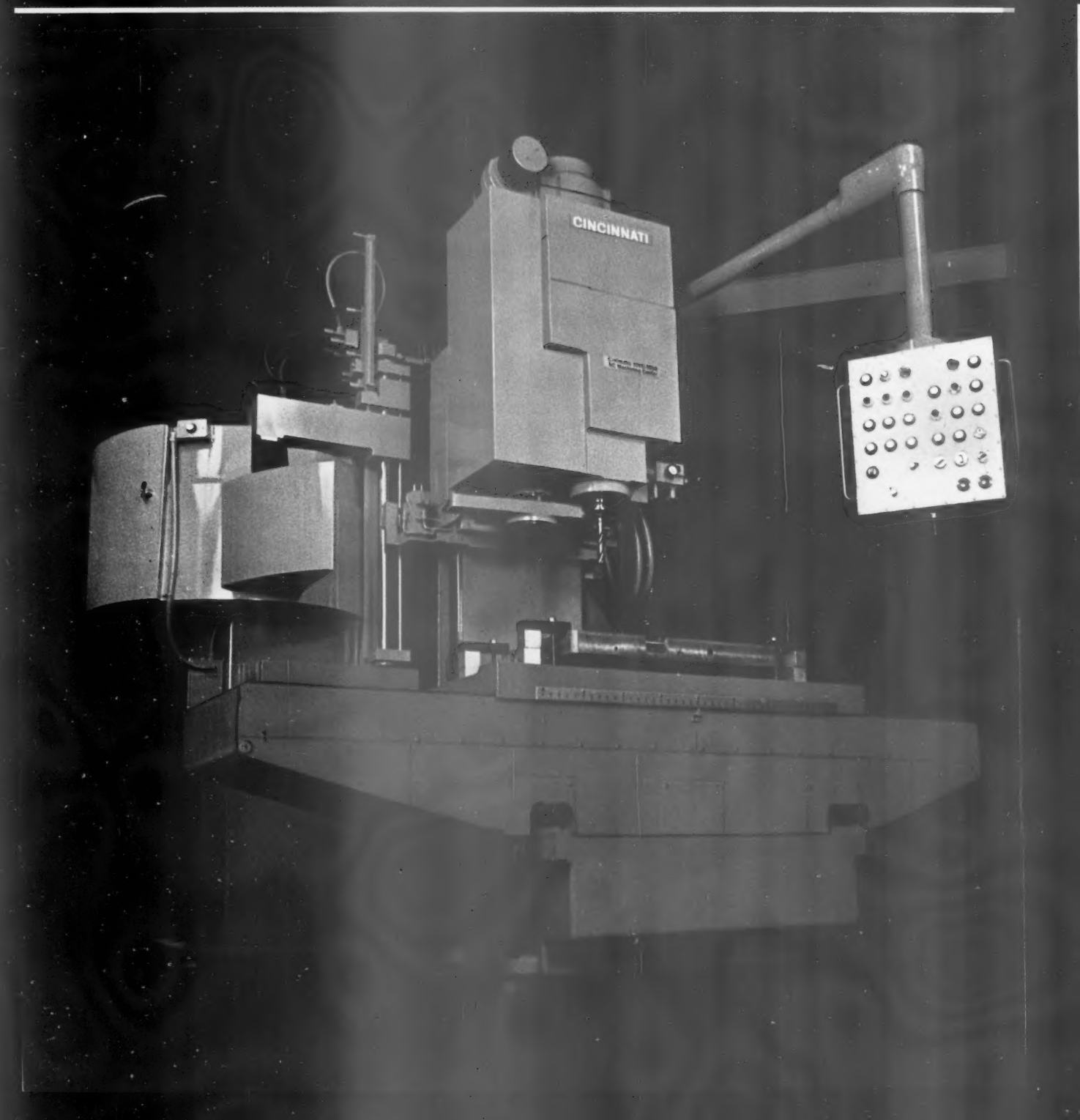
A 32-page brochure describing its **numerical control turning systems** is offered by **LeBlond.**
*Indicate No. 543 on card.*

**A rotary sliderule-type cutting oil selector** indicates the appropriate cutting oil to use for a variety of applications. **Exxon Co., U.S.A.**
*Indicate No. 544 on card.*

Five technical publications are offered by **Sunnen Products Co.** For a 24-page brochure containing 21 case histories showing **what power honing can do,** *indicate No. 521 on card.* For a 12-page brochure, **"More Efficient Honing With Borazon,"** *indicate No. 522 on card.* For a 16-page brochure, **"Fixturing Parts for Power**

*(continued on page 72)*

# New CINTIMATIC® 10VC. Muscle, finesse, and speed you need to increase productivity.



# Take it from Bud, Harry and Frank.

Machining muscle comes from the ram action of the spindle carrier on our new CINTIMATIC® 10VC-1000 NC Machining Center. *There is no quill.* You get rigidity that means deeper milling cuts at faster feeds. Better finishes, too. The spindle drive is 10 HP, DC, with DC servo drives to power all slide movements. A floor-mounted tool drum stores 30 strong, #45-taper tools. Cycle times are shortened by fast, random, tool selection during machining cycle. Spindle orientation improves boring applications, adds to part uniformity.

"Dependable Acramatic 8-D speeds your 10VC along at a 400 ipm rapid traverse in all axes to help cut cycle times even more," adds Frank Hesford, systems manager, Process Controls Division.

The 10VC...and its companion model 10V with manual tool change...give you useful range, too, with 40" in X and 20" in Y standard, 50" x 26" optional. You get 20" of Z-axis range, all under accurate and time-saving tape control, with no manual head settings needed.

"No quill here," points out F. G. "Bud" Weis, plant manager, Cintimatic Division, "and that means milling muscle to me."

ACRAMATIC® 8-D controls the CINTIMATIC 10VC. It is a 3-axis positioning, 2-axis contouring control from Cincinnati Milacron that offers many convenience features. Full manual data input and full range zero shift simplify setup, make short runs without tape practical.

Bud, Harry and Frank haven't told you everything, naturally. Our catalog N-508 tells more. Write for it to Cincinnati Milacron, Cincinnati, Ohio 45209.

"30 tools like these, cutting at 25 to 4000 rpm, give you the machining finesse you need today," says Harry Luebkemann, chief engineer, Cintimatic Division.

**CINCINNATI MILACRON**

The right machine for your job.

INDICATE NO. 222 ON BUSINESS REPLY CARD

KENNAMETAL®

# Kennametal wraps up your tooling package before you unwrap your new N/C machine

At the same time you take delivery on that new N/C machine, Kennametal can deliver a complete N/C tooling package to fit it.

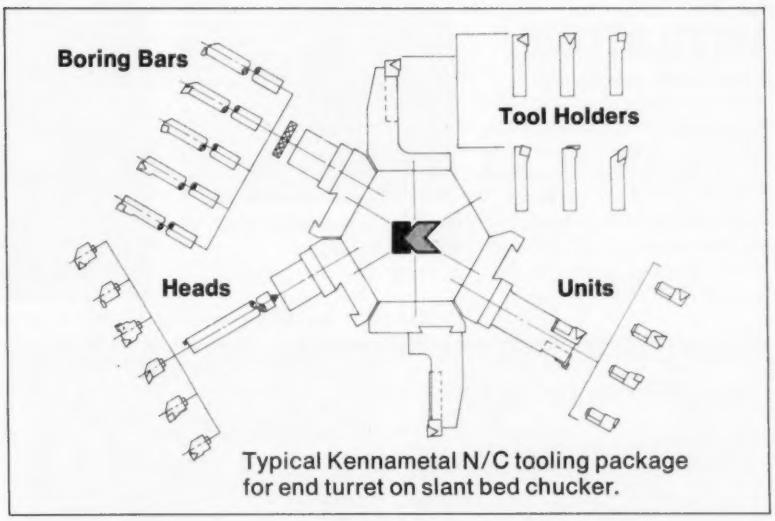
For upper turret machines, our Kenloc holder system can tool over 145 machine models. All holders are qualified to ±.003 and meet ANSI standards.

For end turret N/C machines, Kennametal has steel boring bars, DeVibrator bars with interchangeable heads, solid carbide K-Bars, and flanged bars with Kendex units.

For twin-spindle N/C machines that require tool adjustment within the bar, we have Kenbore bars and heads with axial and radial adjustment. All are qualified.

From this extensive line of tools, Kennametal has developed a complete tooling package for your N/C machine. Each system is detailed in individual catalogs for:

- Cincinnati Milacron N/C Turning Centers
- Warner & Swasey SC-15/17, 25/27, 32/36
- Warner & Swasey 1-SC and 2-SC
- LeBlond Tape-Turn Regal N/C lathes
- LeBlond Tape-Turn IV and 12/12
- Monarch Series 75-110-150-220
- Lodge & Shipley Index Bar Chucker
- Lodge & Shipley Numeriturn III & IV
- Pratt & Whitney Star-Turn 8/15, 12/30



Typical Kennametal N/C tooling package for end turret on slant bed chucker.

- Jones & Lamson TNC lathes
- HES 24 NCS lathes
- Standard Modern 17″ N/C lathe
- American Hustler
- American Panther Series
- Sheldon 17″ and 28″ N/C lathes
- South Bend NC/20 lathes
- Clausing 17″ N/C lathe
- G. A. Gray Ringmaster
- New Britain 11-15-NCV and 66NC
- VDF Boehringer PN Series
- Gidding & Lewis VNC and NumeriLathes
- Hitachi Sieke Corp 5LN Chucker

**Unwrap the package**

Inside a Kennametal N/C tooling package you'll also find all the service you need. Like tool layouts for machining a family of parts. And back-up tooling stock to keep you producing. Our service man can even assist you in start-up. We do all this because we want to do business with you more than once.

To receive any of our N/C tooling catalogs, use the coupon below. For more information contact your Kennametal representative or Kennametal Inc. Phone 412-537-3311.

Send to: Kennametal Inc. • P.O. Box 346
Latrobe, PA 15650

Name _____

Title _____ Company _____

Street _____ City _____ State _____

Phone _____

**N/C machine models** _____

_____

_____

A74-107 F

# KENNAMETAL

# USEFUL LITERATURE

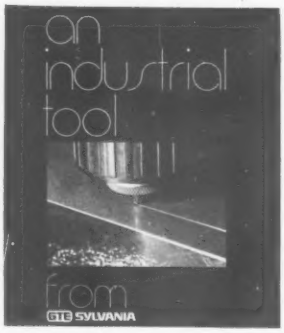
*(continued from page 67)*

**Stroking,"** *indicate No. 523 on card.* For an 8-page bulletin, **"Obtaining Specified Finishes By Honing,"** *indicate No. 524 on card.* For an 8-page brochure, **"Honing Blind Holes,"** *indicate No. 525 on card.*

A 32 page booklet entitled **"Basics of Electrical Discharge Machining"** is offered

by the **Lectra-Form Dept. of Ex-Cell-O Corp.** *Indicate No. 546 on card*

A compact, **powerful laser system** designed to produce acoustical perforations that reduce sound levels aboard




an aircraft is described in a 4-page brochure by **GTE Sylvania's Western Division.** *Indicate No. 584 on card*

A 32-page **idea book** outlining a variety of **power work-holding systems** in metalworking and other production operations, and showing how manual fixtures can be converted to hydraulic power, is offered by **Hytec Division of Owatonna Tool Co.** *Indicate No. 547 on card.*

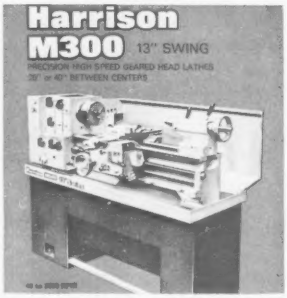
A 66-page booklet entitled **"Facts About Taps and Tapping"** is offered by **Greenfield Tap & Die.** *Indicate No.*

DISTRIBUTED BY

GREENFIELD TAP & DIE TRW INC.

*582 on card.* Also offered is a 50-page brochure, **"Screw Threads,"** describing the unified screw thread system and tolerances, and listing suggested taps and tap drills. *Indicate No. 583 on card*

Several turning machine brochures are offered by **Rem Sales, Inc.**: For a 6-page brochure describing the Harrison **13-in. swing precision**




**high-speed geared head lathes,** *indicate No. 551 on card.* For a 6-page brochure on the **17 in. swing Harrison lathe,** *indicate No. 552 on card.* For a 6-page brochure


## Modern Cuts Any Length Stock — Into Short Parts Fast

Reduce production time. Cut tube, pipe or bar stock to size — fast with Modern Automatic Cut-Off Machines.

Change diameters and lengths in minutes.

Add a Modern automatic feeder and you can hold up to five tons of stock. Feeders load one bar at a time into the machine as needed and handle random lengths without positioning ends.

From start to finish, Modern Cut-Off equipment is completely automatic.

**Capacities for tubing range from ⅛" to 8" OD and bar stock to 3" OD.**

(Manual machines are also available — and just as dependable.)

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MODERN MACHINE TOOL COMPANY

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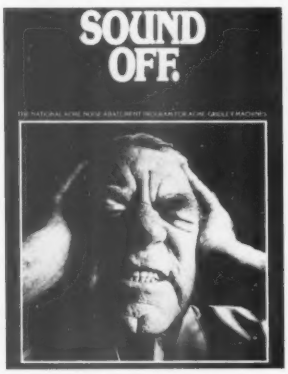
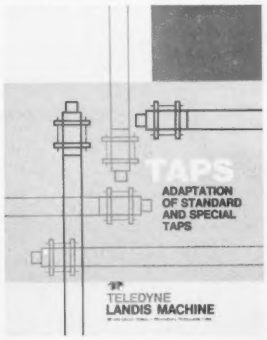
on the **Harrison 21-in. swing precision geared head lathes,** *indicate No. 553 on card.* For a 10-page brochure describing the **automatic Accuratool turret lathe with plugboard program control,** *indicate No. 554 on card.* For a 16-page brochure describing the **Riello multi-spindle drum type indexing machine with 12 heads** for drilling, boring, tapping, and threading, *indicate No. 555 on card.*

Three publications are offered by **National Acme:** For a 6-page bulletin describing the company's **noise abatement program** to meet or exceed requirements established by OSHA, *indicate No. 578 on card.* For an 8-page bulletin on a **multiple-spindle machine** designed to produce ball or roller bearing components, *indicate No. 579 on card.* For an 8-page bulletin covering **collets and pushers** for its multiple-spindle bar machines, *indicate No. 580 on card*




Five booklets covering various aspects of **thread cutting and rolling** are offered by **Teledyne Landis Machine:**




For a 12-page brochure, **"Adaptation of Standard and Special Taps,"** *indicate No. 557 on card.* For an 8-page reference manual on **hollow milling,** *indicate No. 558 on card.* For a 12-page brochure on **how to cut Acme threads,** *indicate No. 559 on card.* For a 12-page manual on **the rollability of materials,** *indicate No. 560 on card.* For an 8-page manual on **roll die life,** *indicate No. 561 on card.*

A number of booklets describing high-production machines it produces are offered by **Standard Tool and Manufacturing Co.:** For a 20-page bulletin, **"Inline Pallet-Type Transfer Machine for Machining Engine Cylinders"** for chain saws, *indicate No. 562 on card.* For a 14-page bulletin, **"Eight-Station Dial Machine For Machining Oil-Pump Housings,"** *indicate No. 563 on card.* For a 13-page bulletin, **"Eight-Station Dial Machine for Machining Gear**

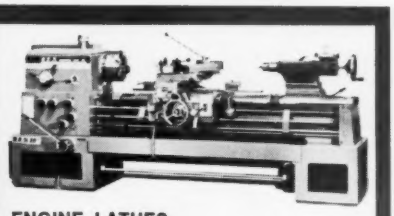
*(continued on page 76)*


Whenever you TURN-TURN to H.E.S.

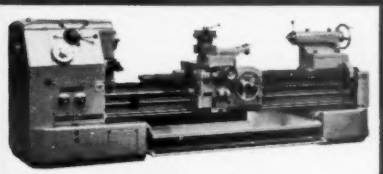
Offering an up-to-the-minute lathe to match your turning needs . . . whenever and whatever they are. From basic engine lathes for toolroom work to sophisticated N/C machines for production runs, H.E.S. has the lathe you need to best suit your needs.

- H.E.S. MACHINE TOOL
- H.E.S. ENGINEERING
- H.E.S. FINANCE

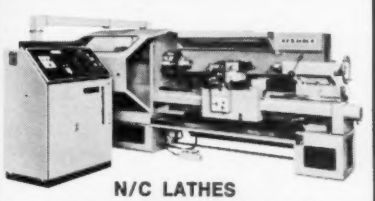
We make it easier to obtain what will be THE PRIDE OF YOUR TURNING DEPARTMENT



ENGINE LATHES
H.E.S. 16, 20, 24.

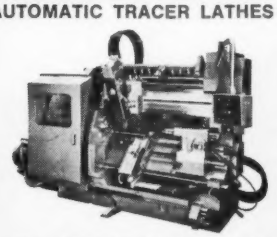


LARGE CAPACITY LATHES
Jupiter 830, Jupiter 920.

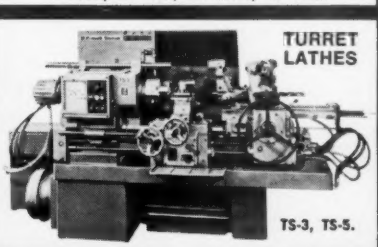


N/C LATHES
14 NCS, 24 NCS, 24 NCSA, 24 NCA.

AUTOMATIC TRACER LATHES



MS-1, Transpilote, S-Pilote, V-Pilote.



TURRET LATHES
TS-3, TS-5.

H.E.S. MACHINE TOOL, INC.
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# Omni-ONE® + SWING® =

# the machining system that "talks" to you.

**Start with Sundstrand's Omni-ONE, the compact NC machining center with a wide range of options and accessories that let you match the machine to the job.**

**Add Sundstrand's SWINC, the soft-wired (CNC) controller with easy-to-use edit, diagnostic, and compensation routines.**

**. . . and you have the most powerful production "system" of its kind.**

## the Omni·ONE®

The OM-1 OMNIMIL® has become the fastest selling machining center ever built by Sundstrand. Big reasons for the popularity are its speed and horsepower. Plus, features that allow the machine to be economically tailored to meet specific job requirements. Features like:

**Automatic tool changer.** Standard 24-position changer lets you load enough tools to handle most part geometries. Optional 60-position changer will handle even the most complex parts . . . or hold two or three tool complements for smaller parts. Changes face mills up to 5" in dia. and T-type boring bars up to 15" in dia. automatically.

**Omnitool® Hi-Speed unit.** Designed for high-speed milling of non-ferrous parts. Automatically loaded through the tool changer. Delivers spindle speeds up to 13,300 RPM and handles end mills up to ½" dia.

**Automatic pallet changer.** Changes pallets by program command in seconds. Virtually eliminates setup time.

**Coolant through spindle.** An important option that dramatically increases machining efficiencies; e.g., drilling operations can be run at speeds up to 300% above normal.

## SWINC®

Takes its name from what it is, a Soft-Wired Integrated Numerical Controller. Developed through years of experience in the field, SWINC is designed around an industrial mini-computer, giving you a more practical, more efficient approach to NC machine control.

**Diagnostics.** A full set of maintenance and diagnostic routines is furnished with every SWINC unit. Plain English instructions on the CRT tell you the cause of machine inhibit.

**Full-edit capability.** SWINC's powerful edit routine easily corrects program errors and discrepancies. With full-edit option, operator can use the keyboard to add to, delete from, or change part programs right at the machine.

SUNDSTRAND®

**Sundstrand Machine Tool**
BELVIDERE, ILLINOIS 61008
division of Sundstrand Corporation

**Omni·ONE & SWINC**
They speak your language.

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# USEFUL LITERATURE

*(continued from page 73)*

**Case and Inserting Bushings,"** *indicate No. 564 on card.* For a 26-page bulletin, **"Inline Pallet-Type Transfer Machine for Machining Valve Bodies,"** *indicate No. 565 on card.* For an 11-page bulletin, **"Electrical Discharge System for Machining Slots in Carburetor Body,"** *indicate No. 566 on card.*

A 32-page brochure describing its line of **standard and**

**special cutting tools** is offered by **Wetmore Cutting Tools.**
*Indicate No. 567 on card*

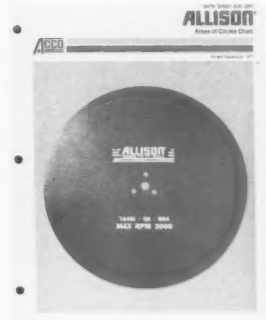
A 14-page booklet describing **the problems that occur in internal grinding and how to**

**correct them** is available from **Bryant Grinder Corp.** *Indicate No. 568 on card.* Also offered is a 10-page booklet, **"Better Centers,"** describing the requirements for center holes for work held between centers. *Indicate No. 569*

**Properties, applications, performance characteristics, and cost** comparisons of **titanium nitride coated carbide** are discussed in a

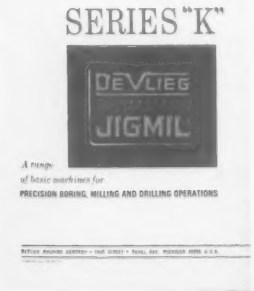
14-page booklet offered by **Teledyne Firth Sterling.** *Indicate No. 570 on card.* Also offered is a 14-page booklet presenting **properties,** applications, and performance characteristics of **cast carbide.** *Indicate No. 571 on card*

**An areas of circles chart for computing the life ratios of abrasive cut-off wheels** is offered by **Acco Allison-Campbell Division.** *Indicate*




*No. 572 on card.* Also offered is a single-sheet **check list of do's and don'ts for diamond dressers.** *Indicate No. 573 on card*

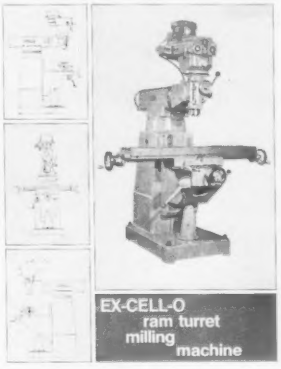
Four machine tool brochures are offered by **DeVlieg Machine Co.** For a 40-page




brochure describing the **Series "K" Spiramatic Jigmil** for precision boring, milling, and drilling operations, *indicate No. 574 on card.* For a 16-page brochure on the Series "J" Jigmil, **a horizontal spindle, table-type boring and milling machine,** *indicate No. 575 on card.* For an 18-page brochure on the **JMC Jigmil machining center,** available with fully **automatic numerical controls,** *indicate No. 576 on card.* For an 8-page brochure, **"The Jigmil Technique,"** *indicate No. 577 on card*

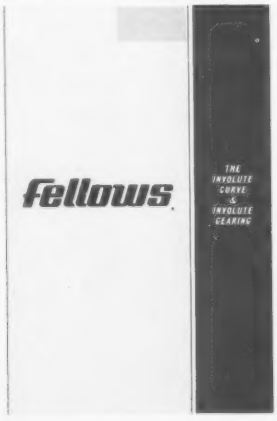
Basic information on **NC turning for job shops** is presented in a 22-page booklet offered by **South Bend Lathe.** *Indicate No. 581 on card*

A 22-page brochure describing its 602 **ram turret milling**




**machine** is offered by **Ex-Cell-O Corp. of Canada.** *Indicate No. 585 on card*

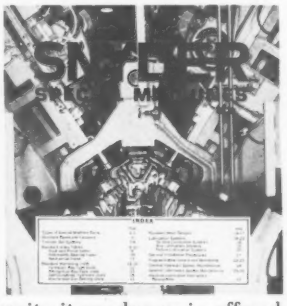
Three booklets concerning the technical aspects of the




gear shaping method are offered by **Fellows Gear Shaper Co.** For the 90-page booklet, **"The Involute Curve & Involute Gearing,"** *indicate No. 586 on card.* For an 8-page booklet, **"The Internal Gear,"** *indicate No. 587 on card.* For a 28-page brochure, **"The Art of Generating With a Reciprocal Tool,"** *indicate No. 588 on card.*

A 4-page folder describing its Crest-Kut **chip breaker end mills** is offered by Weldon Tool Co. *Indicate No. 590 on card.* Also offered is a 4-page folder describing its complete line of **single cutting edge countersinks and deburring tools.** *Indicate No. 591 on card.* For an 8-page brochure describing its **Model S relieving fixture,** *indicate No. 592 on card.*

A 28-page brochure describing the **special machine tools,** index tables, and machining



units it produces, is offered by **Snyder Corp.**
*Indicate No. 599 on card*

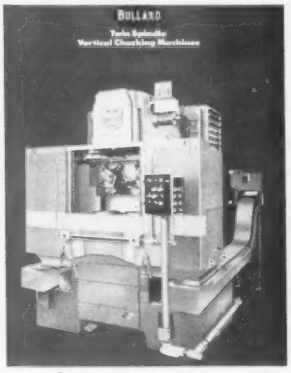
An 18-page brochure describing the **drills, reamers, end mills,** and miscellaneous

tools it produces is offered by **Dixie Tool Industries, Inc.**
*Indicate No. 600 on card*

An 8-page brochure describing its **automatic machines**

**and drilling-tapping units** is offered by Govro.
*Indicate No. 589 on card*

Five publications describing the machine tools it produces are offered by **Bullard Co.** For a 24-page brochure describing all models of **the Templa-Turn line** and containing special data about

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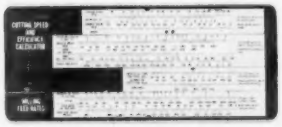
**A sliderule-type cutting tool and efficiency calculator** for



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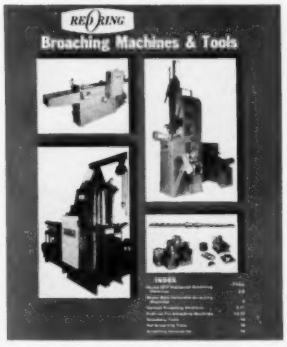


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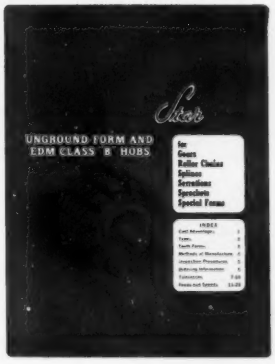


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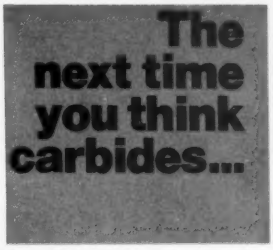


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**A 17 by 22 in. chart showing suggested cutting speeds** for

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# The **FORMING** Industry's Future Challenge:

**Produce larger-size more complex shaped parts, at maximum production rates, while consuming less vital material**

The dark clouds which settled over the forming industry last year show some faint signs of lifting. The primary problem was the almost universal shortage of steel and plastics. Add to this, rising costs, long lead time for new equipment, and growing uncertainty about market conditions and you have the situation as seen by the industry at 1974's end.

1975 opened with some rays of relief in sight. Certainly, the forming industry is not check-mated; its members are relentlessly searching for substitute materials, product redesigns, more efficient processes, and better use of existing methods, all aimed at holding the line on costs and enabling production to continue despite material shortages. Every segment of the forming industry is actively making changes that it expects will help it cope with today's and the immediate future's challenges.

For manufacturers who have not solved their particular problems, the approaches used by some of their counterparts may be useful. The following examples from a broad range of segments of the forming industry may be idea-joggers for your future planning.

**METAL STAMPERS—For them, OSHA relief, expansions, exciting new equipment**

OSHA's repeal of the no-hands-in-dies mandate was the best news stampers heard last year. John H. Stender, assistant secretary of labor and head of OSHA, announced in December that a universal requirement of no-hands-in-dies is not technologically possible at present, and that the costs of modifying or replacing presses, tools, and dies would be prohibitive. The industry's injury data do not support the need for the restriction, he added.

However, stampers are not off-the-hook for point of operation guards; repeal of the no-hands-in-dies rule was followed with strict new regulations. They require failsafe controls designed so a press stroke is halted should a control system failure occur. A monitoring device to improve a press' brake system reliability is mandated. The monitor must stop the press when brake deterioration beyond a predetermined level occurs and prevent subsequent operation until the brake is repaired.

Some of the requirements became effective Jan. 1, but generally the new rules take effect Nov. 1.

**Press Builder Activity.** Builders are working at fever pitch to improve their deliveries. Their major supply problem involves such purchased materials as steel, castings, electric motors and controls, and bearings.

**The safety package installed on a U.S. Baird Model 325 multiple transfer press completely encloses all pinch point areas, fully protecting the operator**

Rousselle Corp. has added a 60,000-sq-ft plant solely for manufacture of double crank presses. Says its president, Robert E. Janis: "Our new plant is custom engineered for the smooth flow production of stamping presses. It is producing straight-side, OBI, and gap presses in the 30- to 300-ton capacity range."

Verson Allsteel Press Co., Chicago, Ill., has expanded its product line by purchasing Cincinnati Milacron's line of Hydroform deep drawing presses.

Schuler Presses America, Inc., the German-headquartered builder, recently delivered its first Americanized presses to an automaker. Engineered and built to U.S. standards, the 400-ton, 108-in. by 96-in. bed press and a 700-ton press feature Schuler's herringbone drive gears for reliability and minimal noise.

In another area of the industry, interesting developments could result from Warner & Swasey Wiedemann Division's agreement to market and manufacture Compu-Cut NC automatic shear systems. These systems are said to increase material utilization through the program of a computer which determines the most economical shearing or nesting method.

"Compu-Cut should become an important addition to our product line," claims John R. Schrecongost, Wiedemann's vice president and general manager. "Although a little different type of machine, its capability and controls are compatible with our NC punch presses and similar machinery."

Productivity improvements and overall cost reductions are being gained by small- to medium-size fabricating shops thanks to four new attractively priced machines introduced last year by Di-Acro Division of Houdaille Industries. The new units represent an extension of, and are compatible with, the company's line of matched metal fabricating equipment. They include a VT-36 NC turret punch, a modified version of the turret punch equipped with a stylus and pantograph feature, a 10-ft power shear capable of processing 10-gage metal, and a 150-ton press brake.

"Primarily, the new machines are helping contract fabricators in the electrical industry expand their capabilities and reduce costs," says Erling T. Moe, Di-Acro's vice president-marketing. "The wide variety of the components (this industry needs) necessitates broad manufacturing flexibility," he explains.

"In one case, a new $2000 shear provided a considerable saving, reduced inventory, and extended the flexibility of one contract shop. In another case, a shop bought a new shear to provide the needed compatibility for high-quality production from an NC turret punch. It eliminated curved edges which an obsolete shear was producing, and effected the .004 tolerance capability from the turret punch," he adds.

**Automotive Expansions.** Within the stamping industry as a whole, the extremely long lead times for new presses is responsible for dampening replacement or upgrading of equipment. Without firm prices and with waits of two years or longer for delivery, many stampers are reluctant to order large presses. The auto industry's expansion of stamping capacity, however, is noteworthy and casts doubts on the prediction that plastics will quickly supplant steel in any important way in major body panels.

Starting with American Motors Corp., two large capacity increase programs are in progress: a $10-million expansion at Kenosha, Wis., and a stamping plant at South Charleston, W. Va.

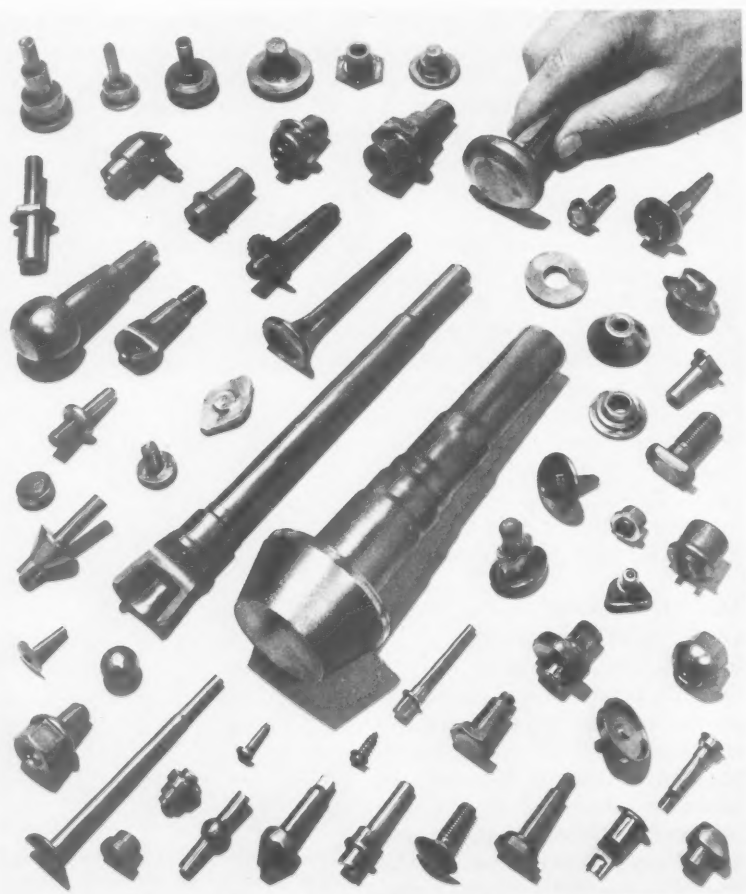
Eighteen new presses at Kenosha will provide three additional major stamping lines, with each line headed by a 1600-ton draw press. When fully activated, the additional facilities are expected to boost the automaker's capacity of stamped sheet metal body parts by about 33 percent.

The newly acquired one-million-sq-ft South Charleston plant is scheduled for full production early this year. Its four major press lines will comprise 21 presses, with the majority being of Danly and Verson makes.

Regarding the additional stamping plant, William V. Luneberg, AMC's president, says: "Activation of our second stamping plant represents a first stage in a series of planned moves in our long-range program to increase our small-car production capacity."

A Ford Motor Co. order for 73 Danly presses undoubtedly lists among the industry's largest recent purchases. The automaker is activating its fifth sheet metal stamping plant at Maumee, O., where 51 of the presses will be installed. The 420,000-sq-ft Maumee plant will house eight major press lines when fully operational. The other 22 will be placed in stamping plants at Woodhaven and Dearborn, Mich., Cleveland, O., and Buffalo, N.Y.

Ranging from 450- to 1800-ton capacity, the new Danly presses feature the builder's Quick Die



**Ranging from a small sheet metal screw to a large pinion blank, this assortment typifies the wide variety of production parts being axial flow formed**

Change mechanism affording flexibility for fast changeovers.

Another automaker wishing to remain anonymous recently installed a huge 60-in. by 220-in. bed straight-side Heim press for piercing floor pans of van-type vehicles. This press features prestressed tie rods, eight-point square full length gibbing, and high tensile gears housed in the machine frame to reduce noise.

**AXIAL FLOW FORMING—**
**Material conservation is giving cold forming methods a tremendous boost**

Advancements in the metal forming area commonly called cold heading necessitates a more descriptive title. Axial flow forming might better describe the processes which include cold heading, upsetting, cold forming, warm forming, and last year's addition—hot forming. These are truly "chipless machining" methods and are displacement processes which squeeze a metal slug of a specific volume into a precise shape within a die cavity.

The benefits of these processes include virtually no scrap and production rates to 36,000 parts per hour. Excellent surface finish, part-to-part repeatability, consistent production tolerances within .001, and improved physical characteristics are other advantages. Add to this list the fact that less costly steel often can be used in gaining parts with greater strength than their machined cousins.

These processes are becoming more widely used to combat rising material costs and material scarcities. A manufacturing engineer in one of the automobile companies says: "Today, we are being forced to consider all materials as gold. We absolutely can't use, or waste, any more material than is vitally necessary." Conventional turning, milling, and other chip-making operations that may waste up to 80 percent of the material and create disposal problems to boot are being reviewed and discontinued as never before.

Most axial flow forming operations are performed at room temperature, and are called "cold forming." However, recent technological advancements have added heat and thereby expanded the process' capability. Heating the material significantly increases its formability, permitting production of more complex and larger parts and extending the process capability to include numerous alloys.

This change in process requires tremendous investment, and, for the most part, the isolated warm and hot forming operations are in the large captive companies, particularly automotive.

**Advantages of Cold, Warm and Hot Forming.** "Warm forming is an expansion of the conventional cold forming capabilities through wider flexibility. It permits forming of difficult parts in one machine, which was impractical in cold forming due to the work hardening of the metal," William Booth, director of sales, National Machinery Co., Tiffin, O., says.

"Warm forming includes annealing of partially formed parts providing for their simplified final forming. Following its processing through several stations, a partially formed part is dropped out of the machine, annealed, fed back to the machine, and final-formed to finished specifications. Depending on the production volume, the part's shape and/or its material, annealing can be a separate remote batch operation or integrated in-line with automated handling.

"An excellent example of an efficient warm forming operation involves a pinion gear used in automobile automatic transmissions. Eight pinions are used per transmission and the about 1¼-in. diameter by ¾-in.-long blanks are warm formed at the rate of 70 per minute.

"The operation is fully automatic. Coil wire fed into a former is sheared to length, formed into a biscuit shape in two operations, and discharged to a conveyor through an induction heating unit. Heated to about 1250 degrees, the biscuits then feed back into the former for finish forming, piercing, and trimming sequences.

"The most recent addition to the axial flow forming process is hot forming. It is accomplished at high temperatures in a fully automatic operation. Although basically similar to forging, hot forming is an integrated manufacturing operation capable of high production rates.

"The automakers were the prime movers behind the development of the hot forming machine. Their objectives are to move more metal faster into complex shaped parts.

"The first of our new line of hot forming machines was recently installed. In-feeding material is induction heated to 2250 F, sheared, and formed at the rate of 150 parts a minute. The largest hot former recently sold to an automaker is capable of producing gears, bearing races, flange parts, etc., up to 4¾ in. in diameter at rates up to 70 per minute.

"We expect other industries to use hot forming when their volumes increase sufficiently to justify the machine system. The process is ideal for economical high production of symmetrical shaped parts which require extensive forming in one direction."

Presently, the variety of axial flow forming machines ranges from single-stroke cold headers to complex seven-station machine systems with integrated material heating equipment. Axial flow formed parts range from #00 screws to large-size parts weighing up to 7½ lb.

**User Experience Widens.** Elco Industries, Inc., Rockford, Ill., ranks among the leading contract manufacturers of axial flow formed parts. The widely diversified company operates 165 cold forming machines ranging from .027-in.-diameter to 1⅛-in.-diameter capacity. Its gross sales climbed to over $49 million last year, a 35 percent gain over 1973.

Jack Packard, executive vice president, says: "Cold forming has been a dynamic fast growing segment of the metal forming industry; however, economic conditions have slowed its progress to some extent. The situation appears to be levelling off, but we expect this year's business to be at a lower level than 1974's.

"Today's most serious problem is the availability of raw materials, and steel is about the worst. Everything is in short supply, and extremely expensive. Domestic steel sources are weak, and the allocations were cut for the first quarter of this year. Foreign steel is out of the question due to its high costs. Materials became a larger portion of our costs last year, and the pendulum swung from a labor-intensive to a material-intensive type of industry.

"The quality of steel is another negative factor. We're forced to buy the types of steel that the mills furnish, even though they may not have the properties we prefer. Unfortunately, a lesser quality steel restricts our flexibility and reduces tool life so we experience higher manufacturing costs. We are trying to overcome this problem, but it requires more sophisticated heat treating techniques, etc.

"The high costs and long delivery of new forming machines presents another serious problem. Not only are the machines expensive, but their costs are increasing by the month, and builders are quoting three to four years delivery. The purchase of new forming machines is a gamble at best. To remain competitive, we can't afford not to buy them, yet hesitate to commit our funds over such a long time period. With the continuing inflationary spiral, a new machine's price can increase by over 10 percent between the time it is ordered and actual delivery.

"For example, we ordered a ¾-in. and a 1-in. capacity cold forming machines in the spring of 1973. They were promised for delivery in 1976 and 1977, with the 1-in. machine quoted at $375,000. By the time it is delivered, the cost is estimated to approach $500,000. Such cost increases can completely wipe out our capital equipment budget. We plan and allocate capital equipment purchases on a long-range basis, but the cost overage must be squeezed from the short-term budget the year a machine is delivered.

"Fortunately, our new machine start-up cost is minimal. We can usually get them into production within a couple of days or a week. Our only problem is getting the tooling to work properly."

Kenneth R. Carlson, director of engineering, adds: "We are also experiencing serious problems with availability of parts and components needed for repair and maintenance of our cold forming machines. Bearings, electric motors, etc., which normally were available in two to three months, now range between six months and two years delivery.

"We bought cold forming machines from England and Germany last year, and in our opinion, they are well-built machines with competitive features. In fact, they are superior to domestic machines in some instances. The cold heading speed is about equal, but their thread rolling speed is faster than U.S. machines."

Continuing, Executive VP Packard says: "Last year we added 137,000 sq ft expanding the plant to 583,000 sq ft. A Miniature Parts Division was added for the production of cold formed parts ranging from #00 to #4. These operations are conducted in a completely enclosed and separated area to maintain their ultra-high quality requirements. These small parts must be absolutely free of all contamination, and between 25,000 and 30,000 can be held in a person's hand. Magnifying glasses are used extensively to examine them.

"In fact, our new Hartford Special Machine Co. cold heading machines are equipped with a built-in magnifying glass and fluorescent lights to aid in observing setup and operational techniques."

**Customers' Needs Changing.** "There are some interesting and beneficial trends slowly developing in the manufacturing industry. For example:

"More sophisticated large-size parts are being designed to be cold formed, which necessitates larger multi-station forming machines.

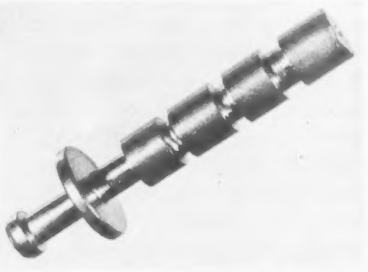
"Tolerance requirements are being relaxed, particularly by the cost-conscious automobile industry.

"Performance characteristics are being specified for fasteners, with the physical dimensions left up to us to establish.

"I also anticipate critical re-evaluation of purchasing practices within the next couple of years. Management, designers, and manufacturing engineers will become more closely involved to obtain the best possible parts for each specific function at the most economical cost."

"Regarding cold forming," Engineering Director Carlson adds, "people often think of the process in terms of small round-type parts. However, the process capability offers far more flexibility; we are producing a wide variety of parts from round, square, hex, octagon, and other wire shapes. Actually, cold forming becomes more economical as material costs increase, and/or as the material becomes the greater portion of a part's total cost.

"As an example, a large hydraulic hose coupling progressed



**Fuel pump plunger cold formed and machined from 52100 steel saves 337 lb for every 1000 parts vs. production on an automatic screw machine**

through two process changes in becoming a cold formed part. Initially, it was produced on automatic screw machines from bar stock. The first process change involved a change to tubing which reduced the cost considerably, but cold forming proved the most economical manufacturing method. We now are producing the couplings on a 1⅛-in. cold former at an estimated 25 percent cost reduction. The part also is significantly stronger particularly in its threaded area.

"In another case, we worked with an automobile company to help engineer a cold formed stainless steel stud for its catalytic converter. The part was initially designed as a screw machine part, but its conversion to cold forming afforded a considerable cost reduction."

**A Time for Re-evaluation.** Camcar Screw & Manufacturing Co., Rockford, Ill., is another progressive contract manufacturer of axial flow formed parts. It has several divisions, each dedicated to specific types of cold formed products; however, its Raycarl Division produces the widest variety of parts for the broadest segment of the manufacturing industry.

Charles Melander, Raycarl Division product manager, says: "We are entering a buyer's market. The national economy has softened to some extent, and I think it will continue to soften more this year. And manufacturers now are searching for more productive and efficient methods and suppliers in their efforts to reduce product costs and improve quality.

"In my opinion, the present economic situation is good for our industry, because the economic pinch will cause many engineers to investigate cold forming. After all, the process' prime advantages are maximum utilization of materials, high production rates, high and consistent quality, and excellent dimensional control of production parts.

"Actually, the opportunity for cold forming of production parts is nearly unlimited. We now are producing parts for the railroad industry which were sand castings for about 50 years. The increasing cost of castings and their shortage caused the manufacturer to investigate cold forming and gain a substantial cost reduction. Similarly, we're now cold forming parts for bearing manufacturers, stainless steel valves for the brewing industry, parts from exotic metals for aerospace, etc., at substantial savings.

"Unfortunately, some manufacturers have not yet 'discovered' cold forming, even though the process is about 100 years old. Many are too stereotyped and are not aware of or willing to try a more economical method of making their parts. They are completely satisfied with their manufacturing methods—until we get the opportunity to convert these unbelievers by showing them how we can move and form metal without making chips.

"Our 'bag' at the Raycarl Division is the capability to produce complex parts in total. In addition to cold forming know-how, we have complete secondary operation production facilities including drilling, milling, broaching, turning, grinding, stamping, plating, etc.

"The Raycarl patented cold forming process is a combination of extrusion and cold forming. It greatly extends the production capability of a two-blow header to produce parts with large diameter areas 25 to 35 times larger than their shank. Basically, it uses larger diameter wire and extrudes a part's smaller diameter shank, while upsetting its head or shoulder. The Raycarl-type machines are built by Waterbury-Farrel.

"Today, the trend in industry is to larger-size, more complex parts. One automotive job involved a caliper pin for the disc brakes which saved $100,000 annually. The one-piece cold formed part replaced a screw machined part and a flat washer. Selective hardening of the threads in a secondary operation improved the product's reliability.

"For Harley-Davidson Co., we are cold forming cup and ball ends for motorcycle engine cylinder valves from 52-100 bearing steel which provide superior strength and wear characteristics at lower cost. Although bearing steel is not conducive to cold forming, we developed some techniques for processing it.

"In another instance, we got a customer to change his material specification from 416 to 430 stainless steel to allow cold forming. The part with a large collar requires heading, reheading, and 14 secondary operations. The customer gets a large savings, including a 50 percent material saving."

**Process Refinements Include Replacement for Stamping.** "Manufacturers seriously concerned with material conservation are learning there are no better economical alternates than cold forming for numerous parts," National Machinery's Booth emphasizes. "Demands are increasing for forming equipment to produce larger, more complex shaped parts.

"Advancements in cold heading and cold forming include faster and larger machines. Improved techniques are also contributing to significantly improved productivity and quality.

"An interesting and unusual application of cold forming is as a replacement of stamping presses in shaping heavy-gage parts. In one specific case, the cold forming machine replaced three presses for the production of shock absorber end caps. The automated forming machine shapes ⅛-in. thick steel disks into dome-shaped end caps at the rate of 150 per minute. The operation provides a significant saving of floor space, material handling, energy consumption, etc., for the user.

"We are on top of the trend to larger forming machines, and have the capability to double their size. Some basic concept changes will be necessary, but National

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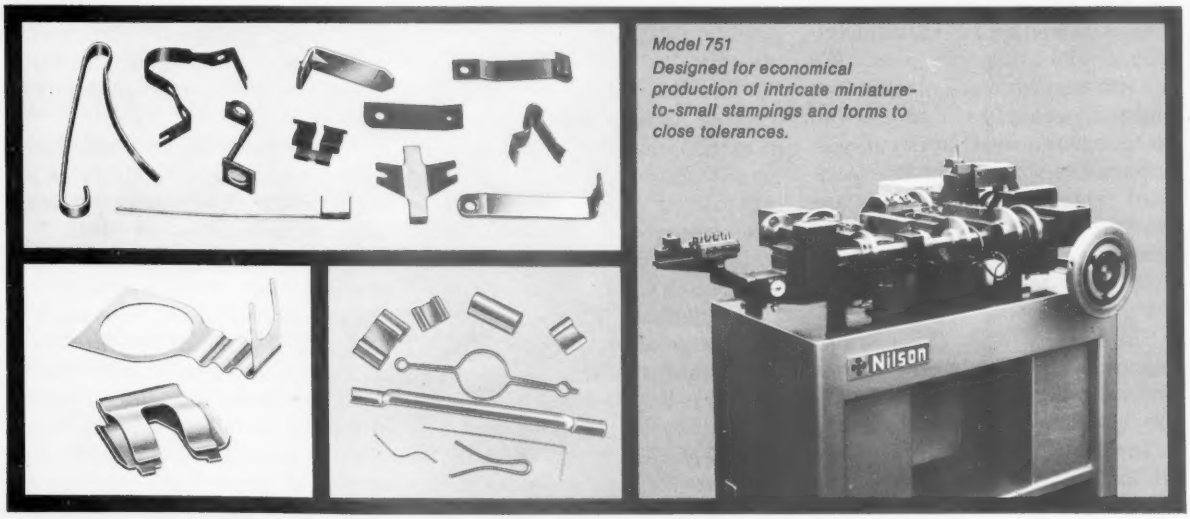
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**The computer adds a new "dimension," easy changeover**

Improvements in tube bending include fully automatic operations, higher productivity, and significantly reduced operator skill requirements.

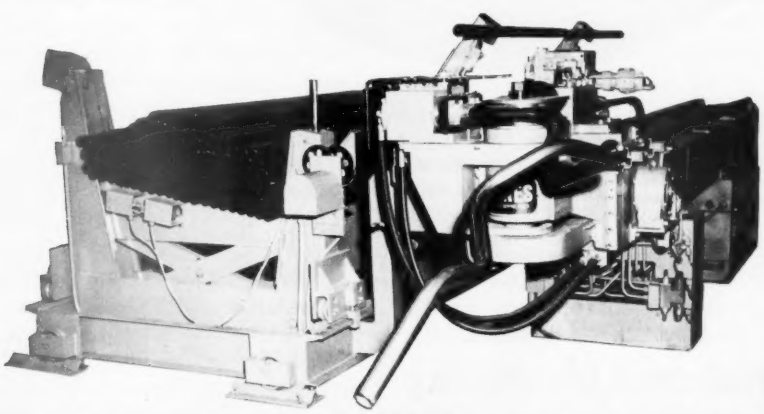
One of the first Teledyne-Pines Automatic Bending Center systems—ABC— is bending tailpipes at an auto part manufacturer's plant. The computer-controlled machine equipped with a 1000-tube capacity mechanical loader bends 200 tailpipes per hour automatically, and some of the tailpipes contain up to 20 complex bends.

Its high production and maximum efficiency are provided by an integrated Computer Automation NAKED MINI minicomputer. Load-unload, clamping and pressure, bending dies, and coordinated movements determining the angles and distances between bends are controlled by the computer. If the control system detects an inoperable condition it halts the machine operation and relays the exact problem and its solution to the operator.

Once the ABC system is set up, its operation is automatic. Operators can easily tend more than one machine.

Changeover downtime is at an absolute minimum. An operator changes the tooling, inserts a new program, and the machine is ready to bend different tubes within a half hour. Normally, a half-day is required to change over a conventional tube bender.

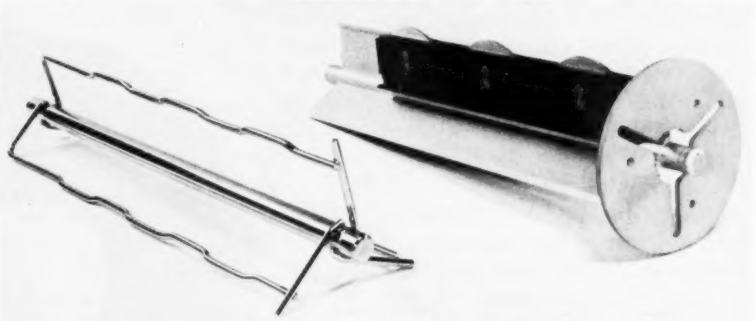
Simple programming by unskilled people is another advantage. A typical seven-bend tailpipe can be programmed by the machine's operator in about five minutes.



**A new computer-controlled Automatic Bending Center complete with tube storage rack and mechanical loader produces various automotive exhaust pipes**

**WIRE FORMING—**
**An important way of retaining part function at a significant materials saving**

Large-scale cost reductions are being achieved by redesigning parts for manufacture from wire forms. The process involves use of automatic four-slide machines, and, if necessary, assembly by welding. Growing at a 10 percent annual rate, wireforming has become a $100-million industry. And recent converts to wire formed parts report savings ranging from 5 to 25 percent with occasional savings above 70 percent.



**The wireformed paper roll on the left afforded a 79 percent cost reduction for a manufacturer of photocopy machines**

Such parts range from simple baskets to multiple-part components. Apeco Corp., Evanston, Ill., gained a king-size 79 percent cost reduction by redesigning a paper roll support for a photocopy machine to a wire form. The new support consists of seven simple parts. Previously, the paper roll support contained 27 parts including aluminum extrusions and metal stampings which required fabricating, machining, finishing, and assembly operations. Among its problems were sharp edges, and some non-symmetrical units caused the paper to "hump" while rolling.

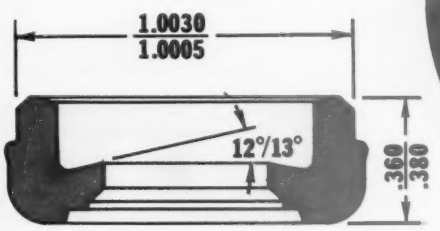
Stono Lighting Division of Keene Corp. in Union, N.J., gained a 60 percent cost reduction by switching to wireformed protective guards for lighting fixtures. Previously, cast aluminum guards were employed. The new guards provide a bonus benefit of increased strength, and the steel's inherent spring-back feature eliminates breakage when they are subjected to impact abuse.

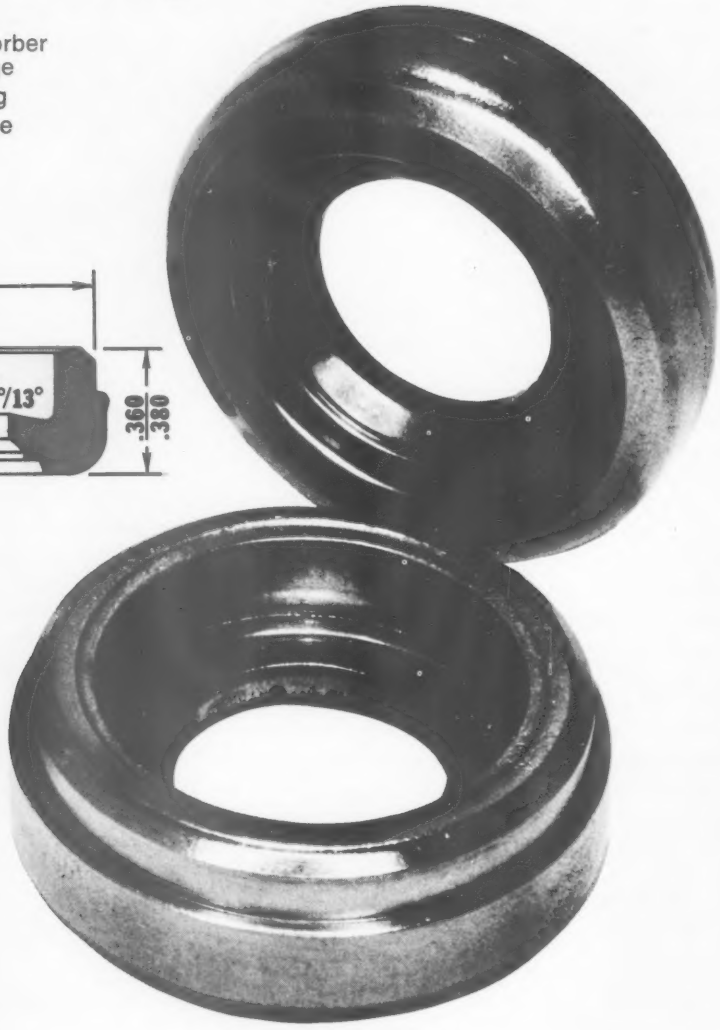
**PLASTIC MOLDING—**
**In prospect, better equipment control, more use of engineered materials; cheap throwaway items take a back seat**

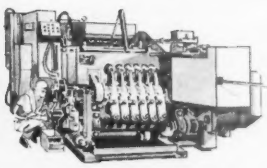
Despite the shortages of plastic materials and their rising cost, this

# From PM to cold forming to save money.

**Part**—Auto shock absorber compression valve cage
**Process**—Cold forming
**Production**—70/minute
**Material**—C1010





Once a powdered-metal part, this valve cage was redesigned for cold forming on a National Six-Die Cold Former. Although this short part has a complex shape, it is practical to transfer. There are more than 20 dimensions and angles to hold within tolerance. The angle on the inside is held with 1°. Intricate shape, close tolerances, and savings on each of 60,000 parts every day. Do you have parts potentially ideal for cold forming? We'll help you evaluate.

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DESIGNERS AND BUILDERS OF HOT AND COLD FORGING MACHINERY



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segment of the forming industry still is growing strongly.

**Current Trends.** "The rapidly growing plastic industry has been slowed by a variety of limitations," says Richard T. Studer, president, HPM Division of Koehring Co. "It started with the energy crunch, and a series of other crises followed. I think we are in sort of a valley situation, which will last for a year or so, before the growth rate resumes.

"Continually rising costs may develop the worst profit squeeze this year ever experienced by the capital goods industry. Even though the economy is slackening, costs keep climbing, and nothing is sacred. For example, we recently ordered a large high-quality casting for one of our machines. Last year, that casting cost $13,000—today, it costs $24,000.

"The continuing rising cost of plastic resins is causing some manufacturers to think twice before specifying plastic materials for low-cost production parts. Thus, there is some balancing off in the types of plastic parts being produced. Throwaway products such as eating utensils, drinking glasses, and novelty items are disappearing.

"Resin suppliers are concentrating on the manufacture of high quality materials. The immediate future growth will probably be paced by the 'engineering plastics.' Further development of these materials will provide characteristics such as improved resistance to heat, cold, and impact. Color match capability will be improved as will ductility.

"Some worthwhile benefits probably will develop from the present situation. There will be more stability in the plastic machinery building industry. Quality and reliability will be improved. Machines will be engineered to withstand more severe requirements in the mold area, produce better products, and maintain more precise tolerances than previously possible.

"Concerted efforts by the builders will be directed to improving machine controls to help molders of precision parts. Such improvements may include process controls to monitor and insure full control of all pertinent elements of the molding process. Improved machine controls could provide the precision capability to exactly fill a mold's cavity. This feature would allow for material savings without sacrificing a product's integrity through molded parts with thinner walls and sections.

"More automation for injection molding machines will afford fully automatic operation and higher productivity. Molded parts can be mechanically ejected to a conveyor or chute for discharge from a machine.

"Competition among plastic manufacturing processes will intensify with domestic developments and as the reaction molding and rim process used in Europe becomes Americanized. Smart manufacturers will be evaluating numerous additional factors in determining their process selection."

**New Applications Abound.** Spearheading the growth of plastics applications is the auto industry. The average 1975 model contains 160 lb of plastic.

Last year, one of General Motors' major research programs involved soft-faced plastic bumpers on a 100-taxicab fleet in New York City. Providing a 76-lb weight reduction, the plastic bumpers also promise a cost saving. Final results will be evaluated after a two-year, 24-million-mile test of the taxi fleet.

Indicating the auto industry's optimism, GM's Fisher Body Division recently added 123,000 sq ft to its Syracuse, N.Y., plastic molding facility. Enlarged to 800,000 sq ft, the operation houses 109 injection molding machines and is the single Fisher Body hardware facility devoted solely to production of plastic parts. At full capacity, it processes about 223 tons of plastic materials daily. Presently, the operation is investigating new uses for plastics to reduce automotive weight.

Plastics, of course, are invading many other industries for a widely varied number of reasons. Injection molding of miniature parts offers an excellent possibility for cost reductions, while maintaining high quality and precision characteristics.

Fortis Ltd., a watch manufacturer in Grenchen, Switzerland, gained an 80 percent cost reduction by changing from machined brass to injection molding miniature parts for high quality 17-jewel wrist watches. General Electric's Noryl thermoplastic resin is molded into watch cases and several intricate internal parts with .0007 dimensional tolerances.

Advantages include reduced energy to operate a wrist watch (because of the plastics' low specific gravity), high strength, resistance to dirt, corrosion, and perspiration, and adequate shock protection.

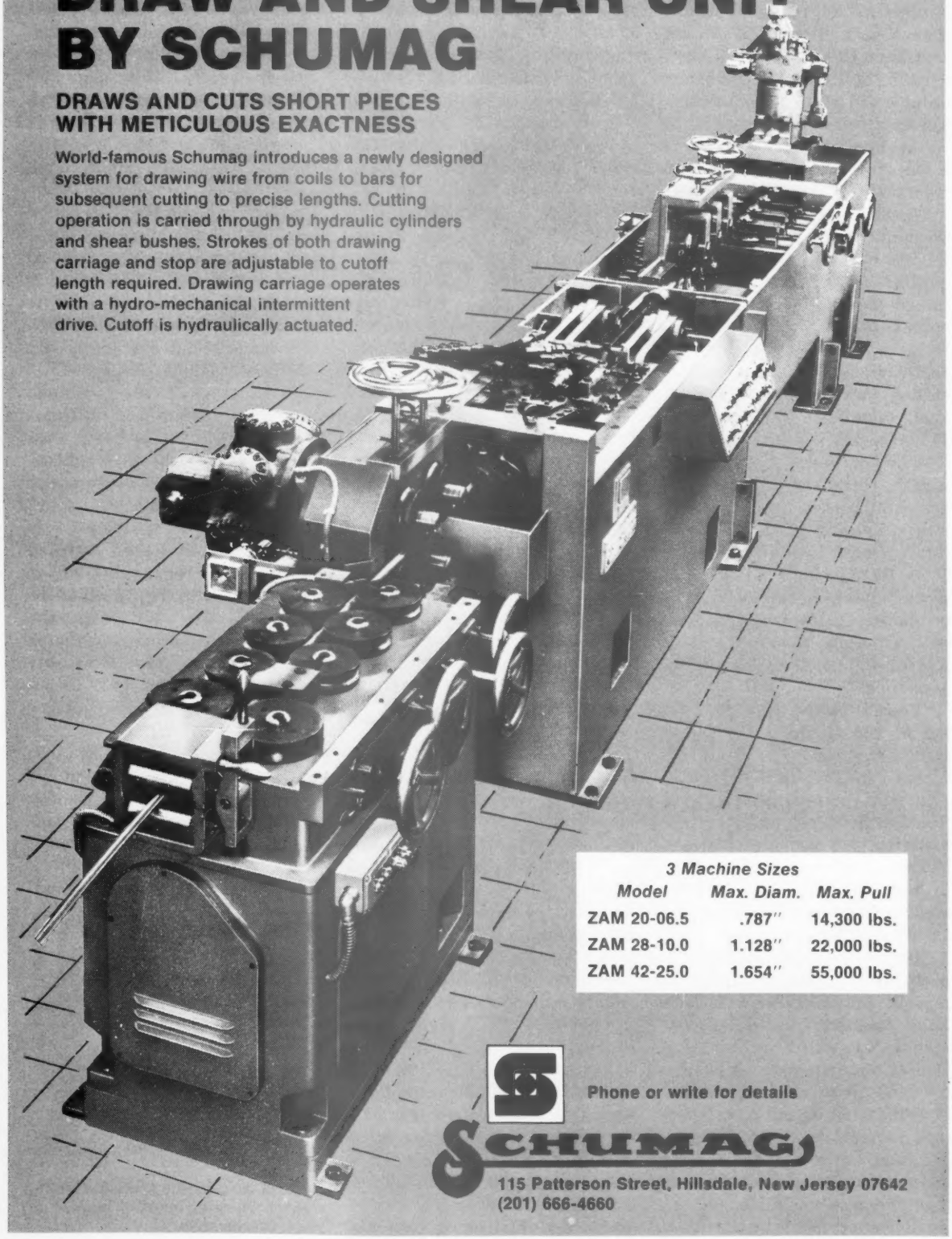
A product redesign coupled with a material change at Glastron Boat Co., Austin, Tex., enabled the company to maintain the product's integrity while reducing manufacturing and assembly costs. A multi-part bow locker door assembly was redesigned to utilize several engineering plastics. A one-piece spring-latch handle injection molded of Celanese Plastic Co.'s Celcon acetal copolymer typifies the advantage of the thermoplastic material in this instance. Spring lock tabs, which hold the door closed,

**A few of the intricate precision wristwatch parts being injection molded of Noryl plastic resin**

# NEW HIGH-PRECISION DRAW AND SHEAR UNIT BY SCHUMAG

## DRAWS AND CUTS SHORT PIECES WITH METICULOUS EXACTNESS

World-famous Schumag introduces a newly designed system for drawing wire from coils to bars for subsequent cutting to precise lengths. Cutting operation is carried through by hydraulic cylinders and shear bushes. Strokes of both drawing carriage and stop are adjustable to cutoff length required. Drawing carriage operates with a hydro-mechanical intermittent drive. Cutoff is hydraulically actuated.



*3 Machine Sizes*

| *Model* | *Max. Diam.* | *Max. Pull* |
|---|---|---|
| ZAM 20-06.5 | .787" | 14,300 lbs. |
| ZAM 28-10.0 | 1.128" | 22,000 lbs. |
| ZAM 42-25.0 | 1.654" | 55,000 lbs. |

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passed a one million cycle reliability test.

Larger size molded plastic parts are appearing. Chrysler Corp.'s Plastic Division in England molds a 6-ft long, 4-lb instrument panel. The panel, used in a light-duty truck, is molded with decorative finished textured surfaces. Made of GE's Noryl resin, the instrument panel costs less and saves weight compared to its metal counterpart. The engineering plastic also resists warping from the "greenhouse" effect of hot sun inside a closed vehicle while its toughness characteristics enable it to withstand impacts at 20 degrees below zero.

**Structural Foam Is Coming On.** At this time, structural foam molding's progress into the basic metalworking industry is slow, in part because of the huge investments in stamping by potential users. It already has made significant inroads in the furniture and sports equipment areas. Foamed mirrors and picture frames, ornamental scroll work, chair and sofa legs, complete housings for musical organs, etc., have replaced high-quality wood counterparts. Sports equipment manufacturers are producing structural foam tennis rackets, skis, hockey sticks, baseball bats, etc.

Among traditional metalworking operations, office machine manufacturers are converting to one-piece structural foam molded housings and bases and reducing costs by eliminating metal fabricating, welding, assembly, and finishing operations.

Still in the experimental stages is a structural foam molded housing for a computer typewriter terminal. Molded in three large parts, the assembled housing presents a smooth-line pleasing appearance without the drum-type noise characteristics of metal. It is extremely rigid and its surface finish is virtually indestructable.

**Help Is There for the Asking.** For potential users of plastic molding processes, there's ample help available in connection with plastic molding manufacturing and processing problems. Several builders of plastic processing machinery maintain elaborate customer-oriented research and development laboratories. For companies considering product redesign, the resin suppliers maintain excellent personnel and laboratories to assist in the selection of the right material for specific functional requirements.

Last year, Cincinnati Milacron's Plastic Machinery Division formally activated a plastic processing laboratory in Batavia, O. Its million dollars worth of equipment includes five 500-ton, 110-oz., and one 1000-ton, 225-oz., injection molding machines; three multi-screw extruder lines; and two rubber injection molding machines along with extensive tooling and testing facilities.

"Our lab is designed to serve three primary functions," explains Larry Schwake, technical services manager: "Customer demonstrations and testing; equipment and process development; and materials testing and evaluation. The lab provides a controlled facility where problems can be isolated and solved one-at-a-time."

## CASTINGS AND DIE CASTINGS—

### Improvements in these forming methods keep them in contention

New foundries with improved methods are spelling good news for castings users. Additional capacity is becoming available to fill the void created by the foundries which closed because of difficulty in meeting clean-air requirements.

Two recent large-scale programs by Ingersoll-Rand Co. to increase casting capacity are indicative. William L. Wearly, board chairman, in announcing plans for a new $10-million high-production iron casting facility said it will contain all new electric melting furnaces, automated molding systems, blast cleaning, core making, heat treat and painting equipment. "The new 250- by 500-ft foundry will conform to all of the existing environmental regulations. It will be a modern, clean, desirable place to work, and an asset to the neighboring community," he asserted.

The new facility is in addition to Ingersoll-Rand's cast iron foundry in Painted Post, N.Y., where an over $1-million modernization and capacity increase program was completed last fall. Casting operations were generally improved and existing foundry equipment upgraded. The lion's share of the program included a process change to chemically bonded sand and related improvements in the mold making operations for medium-size castings.

Likewise, at Latrobe Foundry and Machine Supply Co., Latrobe, Pa., an extensive capacity increase program added new coremaking facilities, including an improved sand handling system, new horizontal twin-screw mixers, new silos, and a seven-station rotary table core molding machine. Furthermore, by standardizing on one grade of molding sand containing a Furan binder the overall operation was improved by eliminating the need for controlling the sand's moisture content.

At Kelsey-Hayes' Gunite Division in Rockford, Ill., a new $2.4-million automated molding system in its foundry for truck wheels features a Herman Corp.-engineered and built system with fully automatic wheel molding in 30-in. by 60-in. flask, 15-in. cope, and a 12-in. deep drag. Integrated mold handling and palletized cooling system will contribute to the system's high productivity.

Cooper Alloy Corp., Hillside, N.J., made a significant breakthrough in productivity by switching from manual sand casting to shell molding for a 225-lb stainless

steel valve body. Benefits include reduced machining, improved product appearance, and a substantial cost reduction.

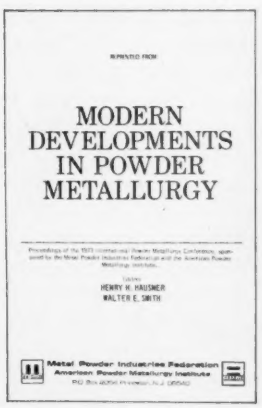
A refinement in another area of foundry operations has been made to the proprietary SQZ process —the squeeze cast or liquid metal process—by Doehler-Jarvis Division of NL Industries, Inc., Toledo, O. The process produces castings with dimensional accuracy, smooth surface finish, and detailed configurations comparable to precise castings and combines these forged part density and properties. It has the capability to cast wrought and nonferrous alloys—including heat treatable alloys—with almost full utilization of the metal poured. With relatively low-cost tooling, automated high production can also be accomplished.

**Materials Savings with Die Castings.** It's possible to save material by redesigning die casting dies. Rem Die Casting Inc., Grand Rapids, Mich., saved 25 percent this way. The redesign maintained integrity but wall thickness for the housing of a single-lever water faucet was reduced from over .090 to a uniform .055. This saving of ¼ lb of zinc effected a 15 percent overall manufacturing cost reduction. And the redesigned die dropped the scrap rate from about 16 percent to less than 1 percent.

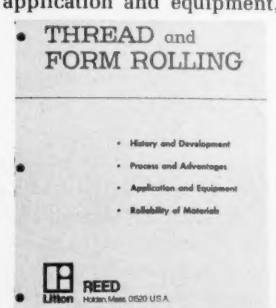
A part redesign to a one-piece die casting fire extinguisher handle from a four-piece assembly provided a whopping cost reduction for Walter Kidde Co. The new die design not only eliminated assembly operations, but affords improved durability and appearance

# USEFUL LITERATURE

**Dry-bag hydropressing** for volume production **of powder metal parts** is described in a 22-page reprint of a paper. **Battelle-Columbus Laboratories.**
*Indicate No. 422 on card.*

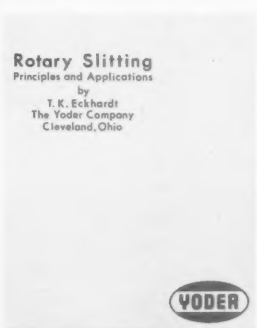



The history and development of **thread and roll forming,** application and equipment, and rollability of materials are presented in a 36-page brochure by **Reed Rolled Thread Die Co.**
*Indicate No. 418 on card.*




**A die designers' handbook,** including time-saver tracing templates, for incorporating Hyson **nitrogen cylinders into manifold plates or die shoes** is available from **Hyson Division, Teledyne Corp.**
*Indicate No. 419 on card.*

A 38-page bulletin entitled **"Rotary Slitting—Principles and Applications"** is available from **Yoder Co.**
*Indicate No. 420 on card.*




A six-part series of articles in a 40-page package entitled **"Transfer Die Technology"** is offered by **Livernois Automation Co.**
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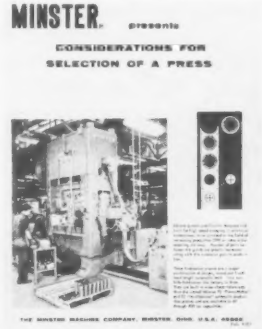
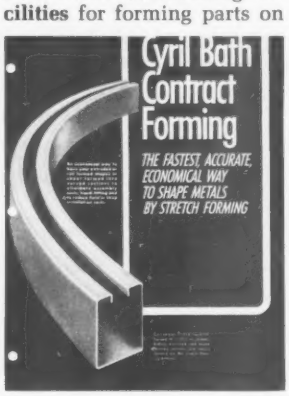
A 12-page brochure containing some 40 illustrations and entitled **"Considerations for Selection of a Press"** is offered by **Minster Machine Co.**
*Indicate No. 405 on card.*




Three publications are available from **Di-Acro Houdaille:** For a 30-page technical bulletin explaining many aspects of **sheet-metal forming,** *indicate No. 402 on card.* For a 20-page bulletin explaining **NC turret punching,** *indicate No. 403 on card.* For a 20-page brochure on **stylus and manual punching,** *indicate No. 404 on card.*

A 30-page **technical manual on tool planning and setup** for horizontal **four slides** is offered by **Torin Corp.**
*Indicate No. 401 on card.*

A 4-page brochure pointing out **the advantages of its in-house stretch-forming facilities** for forming parts on a contract basis is available from **Cyril Bath Co.** *Indicate No. 406 on card.* Also available is a 4-page brochure **"Automatic High Speed Compression Bending and Stretch Forming."** *Indicate No. 407 on card.*



compared to the previous multi-part component. After casting, the part is barrel finished and decorated with a plastic finish coating.

Ford Motor Co.'s Aluminum Casting Plant in Sheffield, Ala., now is die casting a complex aluminum intake manifold for automobile engines. William H. Gay, general manager of Ford's Casting Division, tells how this "industry first" was accomplished. "Intake manifolds had not been die cast due to their intricate shape and passages. Our successful die cast operation followed an extensive development program, including the manifold design, tooling, and production machianes.

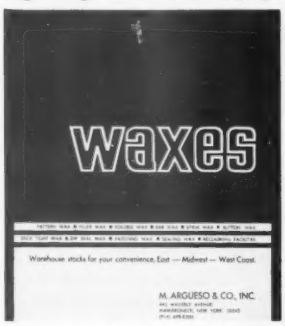
"The aluminum die cast manifold afforts a 60 percent weight reduction, compared to a cast iron counterpart. It provides engine operating efficiency at no additional cost to the customer. We anticipate each pair of molds will produce about 200,000 die cast manifolds before needing replacement.

Alcoa's patented 359 Process is a new way of obtaining aluminum castings with improved strength of up to 300 percent. Its estimated cost is about 10 cents per lb. J. Howard Dunn, Alcoa vice president-research and development, claims that "permanent mold cast aluminum pistons for diesel engines are a future possibility.

"The 359 Process drastically reduces normal microporosity. It involves the exposure of aluminum castings to high isostatic pressure at precise combinations of pressure, temperature, and time. The new process could be justified for any part that could benefit from superior fatigue properties." ■

**Machinery, tooling,** and cost considerations of the **structural foam process** are discussed in a 12-page booklet by **Union Carbide Corp.**
*Indicate No. 408 on card.*

**Waxes for investment castings** are presented in a 4-page brochure by **M. Argueso & Co., Inc.**
*Indicate No. 410 on card.*




A 12-page paper reviewing **the various parameters of control or monitoring** and their effect or influence on the molding process is offered by **Reed-Prentice Division.**
*Indicate No. 409 on card.*

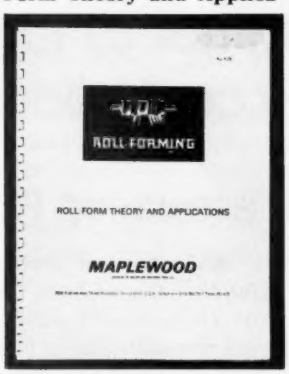
**Modern forging machines** and a variety of techniques are described in a 60-page technical manual by **Hill Acme Co.**
*Indicate No. 411 on card.*

**Case histories** of a variety of parts showing how manufacturers of screw machine parts have saved substantial amounts **by converting to cold forming** are presented in a 16-page booklet by **Camcar Screw & Mfg.**
*Indicate No. 412 on card.*

**How users of circular blanks can cut costs** by reducing scrap loss is discussed in a 4-page bulletin by **Armco Steel Corp.**
*Indicate No. 413 on card.*

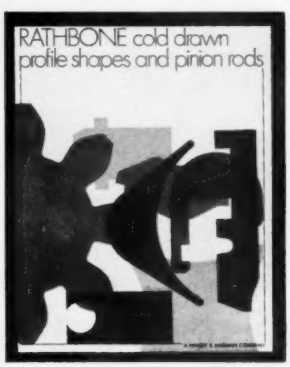
A 16-page brochure discussing the **employment of selected acceleration characteristics** for cam-actuated **press feeds** to facilitate high operating speeds is offered by **Ferguson Machine Co.**
*Indicate No. 414 on card.*

A 28-page booklet, **"Roll Form Theory and Applications,"** is offered by **Ex-Cell-O Corp.,** Maplewood Unit.
*Indicate No. 415 on card.*




Two short papers dealing with **swaging methods** are offered by **Torrington:** For "Swaging Molybdenum & Tungsten at Elevated Temperatures," 6-pages, *indicate No. 416 on card.* For 4-page **"Swaging of Long Tapers on Tubing,"** *indicate No. 417 on card.*

**Profile shapes and pinion rods** cold drawn to customer specifications are described in a 12-page brochure by **Rathbone Corp.**
*Indicate No. 423 on card.*




A 100-page book on **The Heading Story uses the programmed learning** approach to discuss the process and to explain how to select the machine type and capacity to suit your requirements. *Indicate No. 813 on card.* The same step-by-step approach is used in another Waterbury Farrel book, this one 82 pages, three parts on **stamping and drawing.** *Indicate No. 814 on card.*

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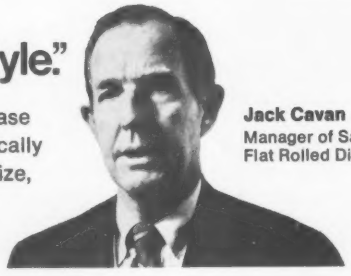

**Jack Cavan**
Manager of Sales
Flat Rolled Division

**Republic**steel



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# **MATERIALS** Changes in 1975—By Plan, Not Happenstance

**Availability, cost, and better utilization are manufacturing men's biggest concerns. Trend to plastics has slowed. High strength low alloy steel comes on strong. Planned change recommended instead of expediency**

Considerable relief from 1974's chaotic materials supply and price situations is in prospect if the predictions which constitute Part II of this report are reasonably accurate. But to expect that "normalcy" is about to return to the manufacturing industries would be to ignore the massive other problems they face.

The short-term business outlook is the greatest of these. While most manufacturers had their production limited in 1974 by their intake of materials and their supply of manpower, the key question suddenly has become: What is our sales outlook? The economy's slowdown at year-end became more widespread and deeper than any of the leading economists had predicted; its duration and degree of recovery is anyone's guess.

How materials are used and what these materials will be also is an important question industry's planners are asking as the result of last year's supply crunch and this year's sales quandary.

A particularly timely examination of these questions has just been conducted under the auspices of the American Society for Metals. Its three-day First National Conference on Materials Availability and Utilization last month in Chicago featured 125 speakers and concentrated on three topics: short- and long-range materials availability trends; guidelines for materials utilization; and the role of design in availability/utilization. The speakers covered steels, specialty metals, nonferrous metals, plastics, and plating materials.

The impact of materials prices on finished goods has radically shifted most companies' pre-1974 complacency to an attitude of top-level concern. But, last year's substitutions at any cost to keep production going are rapidly being supplanted by a strenuous push to bring products' materials cost-contents down.

To sophisticated users, this means the *in-place* cost of the materials, not just their receiving-dock prices. Suddenly, for example, the energy needed for heat treatment or for paint drying becomes a larger factor in the materials selection process. Likewise, the relative amounts of energy needed for the production of various types of materials, and their recyclability, become important factors in their probable availability and long-term price trends.

**Plastics in Jeopardy?** On both of the above counts, plastics should emerge as the winner over other materials.

But, instead, plastics has become a primary question-mark area. The pre-1974 headlong dash to convert metal components into plastic has cooled off substantially. Last year saw many parts swing back to zinc die castings because of uncertainties over plastics' price/availability. And leading users are warning plastics suppliers that unwillingness to make reasonably firm price and supply commitments cannot be tolerated. The design trend to plastics may be interrupted, they threaten.

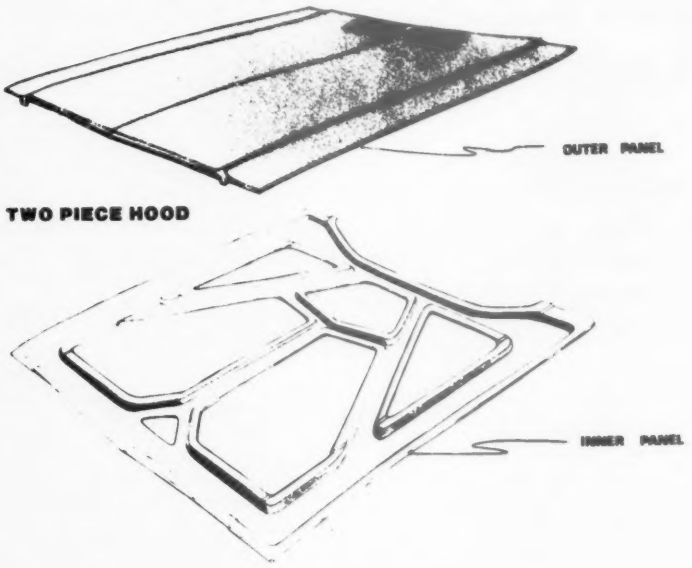
This message came through loud and clear to representatives of plastics producers who comprised most of the audience for a seminar sponsored by the PLANBOOK's and PRODUCTION Magazine's staff. Speaking to them were representatives of General Motors, Whirlpool, Philco-Ford, IBM, Cutler-Hammer, and Rockwell International—companies that have been in the vanguard of innovative conversions from metal to plastic and hope to stay there.

Alan R. Kerivan, vice president, Automotive Products Division, Rockwell International Corp., stressed that "without proper supply and cost projections, we and our customers are not going to be able to bet on plastic materials. I know this is a difficult task, but based on the price of a barrel of oil it should be possible to know what the plastics derived from that oil should cost.

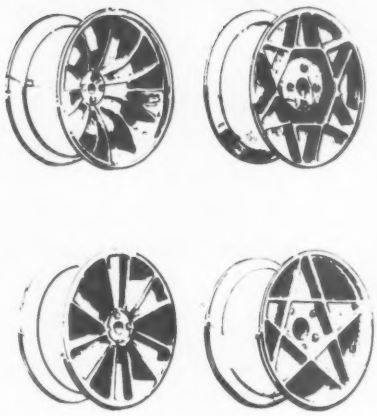
"There is nothing more important the plastics producing industry can do than tell us what we can expect in terms of future supply and price expectations."

Irvin Poston, Head, Plastics Process Development, General Motors Corp., added that "while the plastics industry has had a fantastic growth rate over the past decade, at present it is at a standstill because of capacity limitations and feedstock availability. Essential aspects of its future growth are commitments of availability and price. People who are designing to

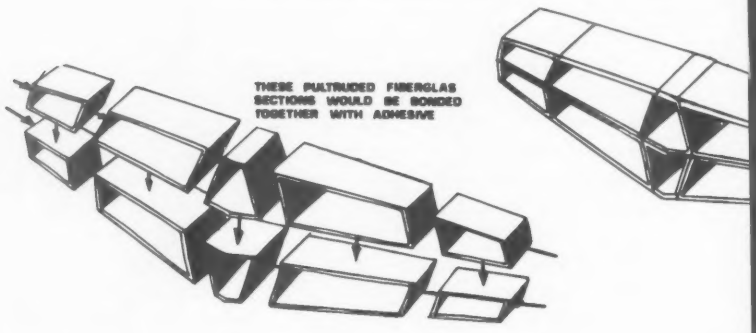
Fiberglas/Plastic Hood Concepts




Fiberglass/Plastic Wheel Concepts



Fiberglas/Plastic Combined Grille/Bumper Concepts for Low Impact Collisions




**Among the possible new uses of fiberglass reinforced plastics in major automotive components are these suggested by Owens-Corning Fiberglas Corp. FRP wheels and plastic bumpers are already being used in a few European vehicles. And some low-volume American cars now use FRP hoods**

use plastics must know what the availability and price will be so proper commitments can be made."

In answer to a statement by a participant that between January 1972 and September 1974, the price of steel had advanced 38 percent and of aluminum 95 percent, while polystyrene was up 55 percent, polyester 138 percent, and styrene monomer 538 percent, Hector Kitscha, director of development, Cutler-Hammer Corp. said:

"If the plastics industry is going to grow, process improvements must be made because there is no way manufacturers can pass through material cost increases of that magnitude. Customer resistance is too great."

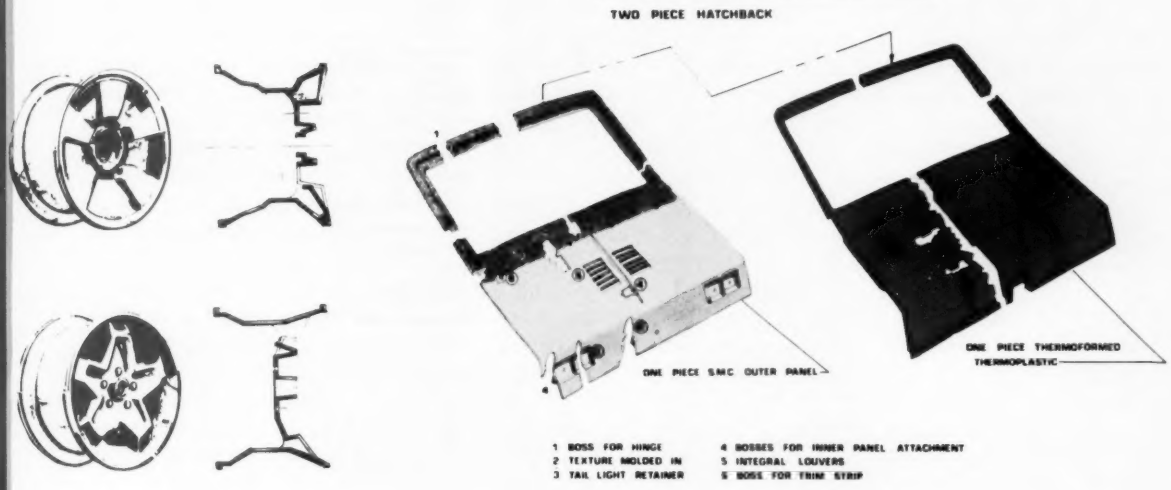
The forecast of 1975 capital spending plans by major "metalworking" industries confirms the current reluctance of many companies to expand their use of plastics in view of the supply/price uncertainties and extravagantly long equipment delivery promises. Of 15 industries surveyed, eight are substantially reducing from the 1974 level the proportion of their capital spending dollar going into plastics molding equipment (for details, see p. 24).

**More Parts Per Pound.** Among the responses by plastics producers to their jeopardized growth is to promote materials and processes that extend resin supplies. Structural foam is getting heavy emphasis as is use of various extenders and fiberglass.

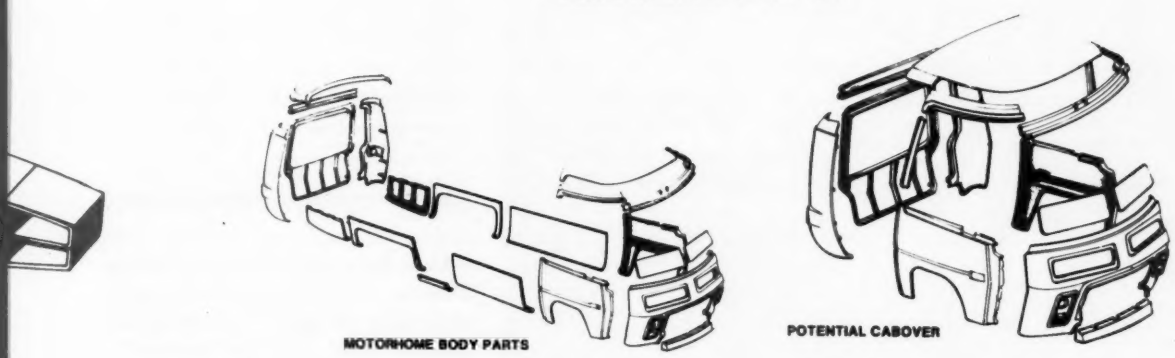
A part made of structural foam can weigh up to 50 percent less than its solid plastic counterpart, according to USM Corp., which produces Farrel and Lombard injection molding machines with structural foam options.

Thom Lautenbach, general manager, transportation division, Owens-Corning Fiberglas Corp.,

**Fiberglas/Plastic Hatchback Concepts**


TWO PIECE HATCHBACK
ONE PIECE S.M.C. OUTER PANEL
ONE PIECE THERMOFORMED THERMOPLASTIC
1 BOSS FOR HINGE
2 TEXTURE MOLDED IN
3 TAIL LIGHT RETAINER
4 BOSSES FOR INNER PANEL ATTACHMENT
5 INTEGRAL LOUVERS
6 BOSS FOR TRIM STRIP

**Fiberglas/Plastic Components for Motor Home and Truck Cab**




points out that glass reinforcement allows thinner components to provide the same strength. A 30 percent by weight fiberglass reinforcement of polystyrene triples the flexural strength of a part or reduces its polystyrene content by 49.5 percent.

While in the past the addition of fillers has been primarily to improve plastics' engineering properties, this action currently is being emphasized in addition as a way of stretching resin supplies.

Philco-Ford's John A. Scarlett, director of appliance operations, says that use of plastic reground material can be increased from that normally recommended. "We have found that we can use 100 percent regrind material with no functional problems." He adds, furthermore, that after an extensive research program with various mixtures of different makers' ABS materials, his operation is obtaining superior material through mixing despite supplier recommendations against it.

**Zinc vs. Plastics vs. Aluminum.** Opinions differ over whether die castings will hold some of the conquests they made last year when designers were forced away from plastics. The zinc die casters have received excellent technical help from Battelle Memorial Institute in a Zinc Institute-sponsored program which aims at materials conservation through improved thin wall die casting techniques and better die design. Often, with properly designed dies, die casters can reduce metal use by 25 percent or more, reduce scrap rates, improve finishes, and reduce the need for secondary operations.

The cost of material is, of course, only one of many factors that planners must consider in deciding which way to go. Comparative material prices as developed by Du Pont, and dated Oct. 7, 1974, are shown in the accompanying table

TABLE 1
MATERIAL COST

| Materials | Specific Gravity | Lbs./Cu. In. | ¢/Lb. | ¢/Cu. In. |
|---|---|---|---|---|
| **DU PONT ENGINEERING PLASTICS** | | | | |
| "ALATHON" Polyethylene Resin | | | | |
| Low Density | 0.914-0.940 | 0.0330-0.0339 | 25-30 | 0.83-1.02 |
| High Density & Copolymers | 0.941 & up | 0.0340-0.0346 | 28 | 0.95-0.97 |
| Vinyl Acetate Copolymers | 0.94-0.95 | 0.0339-0.0343 | 30-44 | 1.49-1.51 |
| "SURLYN" A Ionomer Resin | 0.94-0.96 | 0.0339-0.0347 | 65 | 2.20-2.26 |
| "LUCITE" Acrylic Resin | 1.19 | 0.0430 | 49 | 2.11 |
| "DELRIN" Acetal Resin | 1.42 | 0.0514 | 70 | 3.60 |
| "TEFZEL" 200 Fluoropolymer | 1.70 | 0.0614 | 600 | 36.84 |
| "TEFZEL" 280 Fluoropolymer | 1.70 | 0.0614 | 675 | 41.44 |
| "ZYTEL" 66 Nylon Resin | 1.14 | 0.0412 | 88 | 3.63 |
| "ZYTEL" 612 Nylon Resin | 1.07 | 0.0386 | 170 | 6.56 |
| "ZYTEL" Impact Modified | 1.09 | 0.0394 | 102 | 4.02 |
| **OTHER PLASTICS** | | | | |
| Polyester (thermoplastic) | 1.31 | 0.0473 | 85 | 4.02 |
| Polystyrene-General Purpose | 1.06 | 0.0383 | 33 | 1.26 |
| Polypropylene Resin | 0.905 | 0.0327 | 28 | 0.92 |
| Polyvinyl Chloride (Rigid) | 1.20-1.37 | 0.0433-0.0494 | 30-33 | 1.30-1.63 |
| Styrene Acrylonitrile Copolymer | 1.07 | 0.0386 | 41 | 1.58 |
| ABS Resins | 1.04-1.06 | 0.0375-0.0383 | 45-50 | 1.69-1.92 |
| Modified Acrylic Resin-Rubber | 1.12-1.18 | 0.0404-0.0426 | 58 | 2.34-2.47 |
| Cellulose Acetate Butyrate | 1.19 | 0.0430 | 82 | 3.53 |
| Modified Polyphenylene Oxide | 1.06-1.10 | 0.0383-0.0397 | 75-90 | 2.87-3.51 |
| Polycarbonate Resin | 1.20 | 0.0433 | 96 | 4.16 |
| Polysulfone | 1.24 | 0.0448 | 200 | 8.96 |
| **METALS** | | | | |
| Magnesium AZ-91B-ingot | 1.81 | 0.0653 | 80 | 5.224 |
| Aluminum SAE-306 (380-1% Zinc)-ingot | 2.77 | 0.100 | 52-55 | 5.20-5.50 |
| Aluminum SAE-309 (360)-ingot | 2.64 | 0.0953 | 56-57.5 | 5.34-5.48 |
| Zinc SAE-903 ('Zamac' 3)-ingot | 6.6 | 0.238 | 42.5-75 | 10.12-17.85 |
| Brass-Yellow (#403)-ingot | 8.5 | 0.307 | 63 | 19.34 |
| Brass-85/5/5/5 (#115)-ingot | 8.75 | 0.316 | 77 | 24.33 |
| Steel-CR Alloy-strip | 7.85 | 0.283 | 20.5-25.8 | 5.80-7.30 |
| Steel-Dwg. Qual.-sheet | 7.85 | 0.283 | 11-16 | 3.11-4.53 |
| Steel-Stainless 304-bar | 7.92 | 0.286 | 63 | 18.02 |
| Iron-Pig, basic-pig | 7.1 | 0.256 | 7.78 | 1.99 |

**COMPARISON OF MATERIAL COST**
**REINFORCED THERMOPLASTIC MOLDING RESINS**

| Materials | % Reinforcing Agent | Specific Gravity | Lb./Cu. In. | ¢/Lb. | ¢/Cu. In. |
|---|---|---|---|---|---|
| **DU PONT REINFORCED PLASTICS** | | | | | |
| "DELRIN" 570 | 20 | 1.56 | 0.0562 | 80 | 4.51 |
| "MINLON" 10A-40* | 40 | 1.47 | 0.0531 | 75 | 3.98 |
| "MINLON" 10B-40* | 40 | 1.50 | 0.0542 | 70 | 3.79 |
| "TEFZEL" HT-2004 | 25 | 1.86 | 0.0672 | 650 | 43.68 |
| "ZYTEL" 70 G-13 | 13 | 1.23 | 0.0443 | 100 | 4.43 |
| "ZYTEL" 70 G-33 | 33 | 1.38 | 0.0499 | 100 | 4.99 |
| "ZYTEL" 70 G-43 | 43 | 1.50 | 0.0541 | 100 | 5.41 |
| "ZYTEL" 71 G-13 | 13 | 1.19 | 0.0429 | 103 | 4.42 |
| "ZYTEL" 71 G-33 | 33 | 1.35 | 0.0486 | 103 | 5.01 |
| "ZYTEL" 77 G-33 | 33 | 1.32 | 0.0477 | 175 | 8.35 |
| "ZYTEL" 77 G-43 | 43 | 1.42 | 0.0513 | 175 | 8.98 |
| **OTHER REINFORCED PLASTICS** | | | | | |
| Polystyrene | 20 | 1.20 | 0.0432 | 49-84 | 2.12-3.63 |
| | 30 | 1.28 | 0.0462 | 72-86 | 3.33-3.97 |
| Polypropylene | 20 | 1.04 | 0.0375 | 55-97 | 2.06-3.64 |
| | 30 | 1.13 | 0.0407 | 67-98 | 2.73-3.99 |
| Styrene Acrylonitrile | 20 | 1.22 | 0.0440 | 52-70 | 2.29-3.08 |
| | 30 | 1.31 | 0.0472 | 69 | 3.25 |
| ABS | 20 | 1.21-1.23 | 0.0439 | 72-83 | 3.16-3.64 |
| | 30 | 1.28 | 0.0462 | 77-88 | 3.56-4.06 |
| Polyester (thermoplastic) | 30 | 1.52 | 0.0549 | 86 | 4.77 |
| Polyphenylene Oxide (modified) | 20 | 1.21 | 0.0436 | 110-115 | 4.80-5.01 |
| | 30 | 1.27 | 0.0458 | 115-120 | 6.30-6.58 |
| Polycarbonate | 20 | 1.34 | 0.0484 | 150-158 | 7.26-7.64 |
| | 30 | 1.43 | 0.0516 | 138-150 | 7.12-7.74 |
| Polysulfone | 20 | 1.38 | 0.0498 | 180 | 8.96 |
| | 30 | 1.45 | 0.0523 | 180 | 9.41 |

*With the exception of "Minlon" 10A-40 & 10B-40, all compositions are glass reinforced/filled.

TABLE 2
FACILITY COST ELEMENTS

| | DIE CASTING | INJECTION MOLDING |
|---|---|---|
| **MATERIAL COSTS** | | |
| Finished part | X | X |
| Remelt scrap losses | X | X |
| **PROCESSING COSTS** | | |
| Melting, handling ingots | X | X |
| Casting | X | X |
| **MAINTENANCE** | | |
| Monorail, transfer transportation | X | |
| Die-cast machine | X | X |
| Primary tooling | X | X |
| Rebuilding furnaces | X | |
| **SUPPLIES** | | |
| Storage inventory | X | X |
| Flux, oil, die-replacement | X | |
| **GAS AND ELECTRICITY** | X | X |
| **SUPERVISION & SET-UP** | X | X |
| **LOSSES** | | |
| Material scrap | X | X |
| Reject parts | X | X |
| **FINISHING COSTS** | | |
| Deflash, trim | X | |
| Sand, deburr, handclean | X | |
| Drill, tap, ream, spot face | X | X |
| Handling station-to-station | X | |
| Inspection | X | X |
| Reject losses | X | X |
| Gauges, jigs, tools | X | |
| Maintenance | X | |
| Secondary trim dies | X | |
| Transport system | X | |
| Secondary machines | X | |
| Electricity | X | |
| Supplies | X | |
| Oil, grease | X | |
| Supervision & set-up | X | |
| **SURFACE FINISHING** | | |
| Degrease | X | |
| Honite, paint, plate | X | |
| Handling | X | |
| Rejects | X | |
| Maintenance | X | |
| Paint racks | X | |
| Transport system | X | |
| Supplies | X | |
| Paint material | X | |
| Degreasers | X | |
| **FACILITY MAINTENANCE** | X | |
| Smoke stack, vent repairs | X | |
| Anti-smog equipment, supplies | X | |

(Table 1). Other cost factors, as listed by General Electric's Plastics Division, are shown in Table 2.

GE notes that zinc can be processed approximately three times as fast as polycarbonate and aluminum slightly faster, but adds that plastics' savings over the secondary finishing often required for die cast parts more than compensates for the molding cycle time disadvantage.

Zinc die castings of less than 0.1 lb and requiring nominal finishing can almost always be produced at less cost than similar parts of Lexan, the plastics producer admits, but when parts are over that weight (or when extensive secondary work is required) the advantage begins to shift, the company's experts assert.

**Converting with a Long-Range Plan.** Last year, as an expediency, many manufacturers made slight product design and specification modifications so a variety of materials could be used, the choice at a given time being dependent upon material price and availability, and upon open processing equip-

ment time.

This, manufacturing men admit, is "a hell of a way to run a railroad" although it was a way of keeping their operations going at reasonably full blast. Obviously, it violates most of the long-range planning rules and optimum product cost/performance criteria by which manufacturing and design organizations normally live.

Such an atmosphere is not conducive to product improvement and manufacturing cost reduction, which, over the long run, are where competing materials will earn their right to survive or grow. Major companies, in fact, stress the need for detailed planning that enables materials changes to be made most advantageously.

Rockwell Automotive's Kerivan emphasizes the value of a conversion plan, taking fully into account all the reasons a particular material is selected. Over the years, he says, "the designer has had the chance to go any direction he wanted—to die castings in zinc or aluminum, to stamped metal, or to plastics.

"These materials will generally be chosen either for their cost or their performance. But more appropriately, they should be selected for *both* their cost and performance." And in making a change, he declares, "the 'why' of that change becomes an important part of the conversion plan." These "whys" then call attention to the areas "where the user can take full advantage of the reasons for his choice."

Such a plan, Kerivan explains, will take into account the differences between the material presently used and that to be used in the future. Ideally, it will also look beyond the first generation of parts in the new material and will outline how later generations can further exploit the new material's advantages. Parts consolidation is, of course, one of the important "whys" that a materials change can open up. And the effects of such consolidations will be felt at numerous stages of the overall production operation. The conversion plan, he asserts, will anticipate each of the effects and will determine how the organization will prepare for it.

**Plastics Conversions in Action.** Cutler-Hammer's Kitscha, IBM's Robert D. King, advisory engineer, Plastics Application Department, and Whirlpool Corp.'s J. W. Adams, director of manufacturing research, provide examples of increased plastics use in recent years.

Adams notes that Whirlpool's changes of die castings to plastics has included water pumps, plated knobs and door handles, and gears. Sheet metal parts that have been changed to plastics include bearings, consoles, splash rings, fan housings, floor wheels, vacuum cleaner bases and hoods, refrigerator crisper trays and covers and liners. "We have made these changes to achieve quality and performance improvements, cost and noise reductions, to improve our mounting techniques, to make energy savings for ourselves and our appliance customers. And," he adds, "to delay major capital expenditures."

One problem when going to plastics, he tells, is the difficulty of determining in advance exactly how the material will mold and how it will perform in service.

"We can predict what will happen when we make a metal part with the various processes available to us. In plastics, and particularly the large parts, however, we generally must go to complete production tooling, make samples and tests, revise the tooling and make further tests. When we're finished, we often find we have very expensive tooling that has had to be somewhat chopped up. A major need is a material for low-cost prototype tooling so we can refine our designs and processes at lower cost," he explains.

King of IBM reports that "10 or 15 years ago if 5 or 6 percent of our machines' parts were of plastic, that would have been a large number. Today, we're talking about a third of the component parts in our machines being plastic. That's a lot of change in a relatively short time!"

The change, he says, has occurred in two ways: "by taking an application designed in sheet metal or as a die casting or some other nonplastic material and cost-reducing it as a plastic part; or through evolution, with plastics being used not for a direct part-for-part materials replacement but for its contributions to the overall functions."

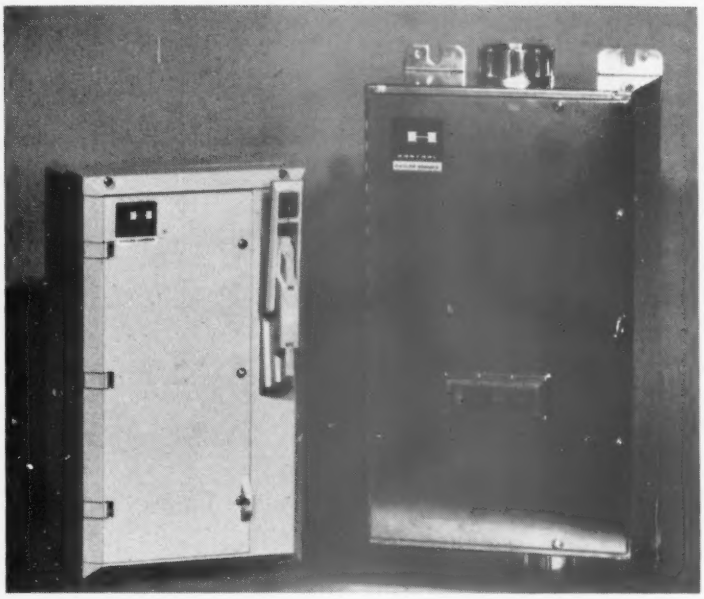
This evolution-type change has been particularly needed as many IBM products changed from largely mechanical to extensively electronic, and were reduced in size. "In the early days," he relates, "we made a tubular frame and screwed on sheet metal panels to form the machine's cover.

"Today, we take a plastic structure, which is also the exterior of the product. And all the internal attachments, the power supply, the bracketry, and the machine functions themselves are fastened to this cover.

"We no longer have a frame involved in the construction of the machine; everything is within the one-piece molded part." Such covers frequently now are of structural foam, and thermoplastic materials usage is growing faster than thermoset currently, he adds.

Cutler-Hammer's Kitscha looks for his company's use of thermoplastics to increase from its present 5 percent of an annual consumption of 6 million lb of plastics to 15 percent by 1980 as higher temperature-resistant materials become available. Four new thermoplastics with heat resistances in the 450 to 600 F range are currently being evaluated, he reports.

One recent metals to plastic conversion is the use of a glass-filled polyester thermoplastic electrical control cabinet replacing a stainless steel unit for the food and chemicals industries. It has better chemical resistance and is less susceptible to trapping food particles while also being man-



**One of Cutler-Hammer's newest conversions to plastics is for an electrical control cabinet, replacing the stainless steel unit at right for the food and chemical industries. Much of the company's design work currently, however, involved upgrading parts for the improved and newly developed plastic materials**

ufactured at lower cost.

"As we look into the future, we see many excellent materials emerging that will enable us to make new materials trade-offs beyond those we already have made. In many cases, we've gone beyond changing from metals to plastics, and we now are constantly changing from one type of plastic to another to improve product performance and in many cases to also reduce costs," he explains.

**Powder Metal and Cold Forming.** The advanced manufacturing development manager of a leading jet engine producer contends that powder metal will make its biggest breakthroughs in the next five years. He considers the amount of metal wasted through machining processes shameful and the investment in machining equipment intolerable.

Automotive men, too, look for important expansions in powder metal use, particularly toward larger parts, but consider themselves temporarily stymied by the cost and delivery wait for the necessary higher-tonnage equipment.

At the moment, another problem on larger parts is obtaining reliable density through sintering in high-volume operations. Induction heating may be the answer. The powder metal's cost is advantageous, but the equipment investment for what will be regarded as experimental programs for a few years at least rules this work temporarily out of active consideration by the automakers.

Meanwhile, the favored chipless machining processes are cold, warm, and hot forming (see p. 79). "We have to assume that material will be scarcer as time goes on, and we've been told by our management that we've got to regard materials and weights as though they are gold," explains one automotive manufacturing engineer. "This means we're trying to get out of the chip making business and into the parts making business. The easiest route seems to be through cold forming."

Increases in applications of cold forming to larger parts, however, are being held down by equipment costs, delivery time of up to three years, and perishable tool costs. "This is the reason our industry is sticking basically with small parts," the automotive man declares.

**Steel Conservation Actions.** Steel shortages last year prompted producers and users to find more ways to make a given tonnage of steel go further. While undoubtedly many low-value products were taken out of materials producers' rolling schedules as a way of maximizing profit, the producers also changed the mix in favor of products where output yield per ton of raw steel also would be higher.

Switch from sheets to coils was one of the more-obvious advantageous moves for both users and suppliers. One cut-to-length sheet user—a building products manufacturer—found he was ordering 53 different items which, by slight thickness compromises, could be reduced to 31, with coil used instead of sheet. His cost saving was 15 percent—over $100,000 a year, according to Armco Steel's Technical Services Department.

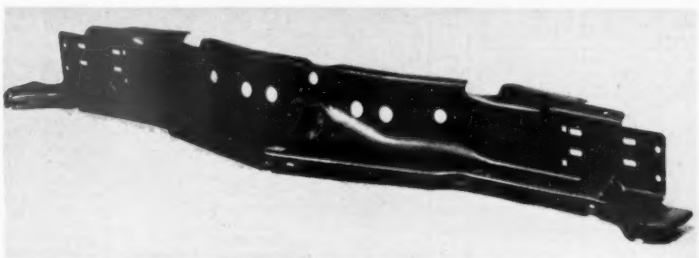
Better nesting of parts is another action cost-conscious users presumably have always stressed. But top-level emphasis on materials conservation brought to light many instances last year where further improvement could be made.

Robert Bowen, material control manager of Ford Motor Co.'s Metal Stamping Division, calls "phenomenal" the 25 percent reduction in amount of offal generated in his operations in the past four or five years.

Many manufacturers have found they can use thinner steel gages without sacrificing product performance or durability, and others have found they could,

through slight part redesigns, avoid paying special width extras.

The galvanized steel producers have been promoting their G60 steels painted as a replacement for bare G90 in weather-exposed products. For two different air-conditioner parts, for example, the per-ton saving by switching to lighter zinc coating for one user amounted to $3.50 and $3.80 with easier fabricating and welding an additional "plus." Use of Diamond Shamrock's zincrometal, which uses only about 8 percent as much zinc as galvanized sheet, was the way one automaker alleviated the galvanized sheet shortage last year.



**The improved formability grades of high strength low alloy steel have expanded HSLA's automotive applications in the last two years and further gains are expected. Adequate strength in lighter gages for significant weight savings is a major advantage. Above is the Oldsmobile Toronado's rear bumper reinforcement**

**Trend to HSLA Sheet Steel.** The combination of factors that converged last year—materials stringency, emphasis on weight reduction in many products, avoidance of heat treatment, and improved formability—are making the high strength low alloy steels important "comers" in many products where common low carbon steels have generally been used.

The automotive industry, particularly, has seized on these materials to advantage and currently uses about 60 percent of the producing mills' 650,000 annual tonnage. From the 1973 usage of 62 lb of hot-rolled HSLA sheet and strip per average car (up from 1972's average of 36 lb per car), automotive designers think it possible that 250 to 300 lb of HSLA may in time be used, and that for 1977 models an average per-vehicle use of 200 lb is likely.

These materials are available in hot-rolled gages down to 0.071-in. minimum thickness and up to 0.229 in. Cold-rolled is available below 0.071-in. thickness.

While most HSLA usage to date has been of the hot-rolled material, cold-rolled may gain in favor as designers find they can obtain adequate strength and good corrosion- and dent-resistance with thinner sections, according to the American Iron & Steel Institute's Committee of Hot-Rolled and Cold-Rolled Sheet and Strip Producers.

A previously unpublished selection guide to hot-rolled HSLA developed by AISI and appearing herewith (Table 3 on pp. 100-101) indicates the yield point, tensile strength, formability, weldability, and likely application areas of these impressive and, in their improved formability, new steels.

## PART II—
## THE MATERIALS OUTLOOK

Faster than they came, the shortages of raw materials and of most components are dissolving. Item by item, here is the 1975 materials outlook as developed by the Materials Division, U.S. Department of Commerce.

**STEEL**—Lower overall demand and a rise in imports will cause the steel industry to slightly reduce its production. From the record levels of 1973 and 1974, domestic raw steel production will ease 1 percent to 148 million net tons, and shipments of finished steel will drop 5 percent to 104 million tons.

Supply at 1974's end looked like it would remain tight for the first half of 1975 with the easing to become more noticeable in the second half.

There will be a weakening in the price of imported steel brought about by an easing in worldwide demand. As a result, imports may jump 14 percent, to 14 million tons. Exports from domestic mills will drop from the estimated 1974 level of 6 million tons to 5 million tons.

Looking beyond 1975, steel from domestic mills will remain in generally tight supply despite the addition of more than 12 million tons of raw steel capacity over the next three to six years. It is estimated an additional 15-20 million tons of capacity would be required to fully satisfy the predicted increase in demand by 1980.

**FERROUS CASTINGS**—What probably was the tightest materials item in 1974 will move into a somewhat easier position this year, with shipments of ferrous castings increasing about 6 percent to 20.5 million tons from 1974's estimated 19.4-million-ton level. This presupposes that the foundries will find relief from the shortages of pig iron, coke, ferroalloys, resins, and other items that caused an estimated 3 percent reduction in their output in 1974.

Imports of ferrous castings are seen rising by 11 percent in 1975, with most of these parts coming from Canada, the United Kingdom, and Japan.

A 3 percent annual growth rate in ferrous castings shipments is expected to 1980, with shipments by that time reaching 23 million tons, and their value increasing by

## TABLE 3

Selection Guide to High Strength Sheet Steels—Carbon & Low Alloy (HSLA)

| Product Designation | Type (Chemical Composition) | Yield Point, PSI (Minimum) | Tensile Strength, PSI (Minimum) | Elongation,* 2" (% Minimum) | FORMABILITY | | | WELDABILITY | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | STRETCHING | DRAWING | Cold Bending | RESISTANCE SPOT WELDING | FUSION WELDING |
| For Reference: Regular Low Carbon (0.15 C Max.) | C, Mn | 30000-35000 (Typical) | 50000 (Typical) | 34 (Typical) | THE BEST FORMABILITY IS AVAILABLE IN THE HIGH STRENGTH LOW ALLOY STEELS WITH INCLUSION SHAPE CONTROL. FREQUENTLY REFERRED TO AS "HSLA WITH IMPROVED FORMABILITY." IN DECREASING ORDER OF PERFORMANCE IS HSLA KILLED, HSLA SEMI-KILLED, AND CARBON RE-NITROGENIZED OR RE-PHOSPHORIZED STEEL. OF COURSE, THIS ORDER IS BASED ON THE STEELS BEING PRODUCED TO THE SAME MINIMUM YIELD STRENGTH. DIFFERENT YIELD STRENGTHS PRESENT MORE COMPLICATED COMPARISONS, ALTHOUGH AN HSLA IMPROVED FORMABILITY STEEL WITH A GIVEN YIELD STRENGTH FREQUENTLY OUTFORMS AN HSLA SEMI-KILLED OR CARBON RE-NITROGENIZED OR RE-PHOSPHORIZED STEEL AT A LOWER YIELD STRENGTH.<br><br>THE FOLLOWING APPLIES TO THE IMPROVED FORMABILITY KILLED GRADES. HSLA SEMI-KILLED AND CARBON STEELS HAVE LIMITED STRETCHING AND DRAWING CAPABILITIES. RE-NITROGENIZED AND RE-PHOSPHORIZED CARBON STEELS ARE GENERALLY NOT RECOMMENDED FOR DRAWING APPLICATIONS.<br><br>BASICALLY, FOR PURE DRAWABILITY, THERE IS LITTLE, IF ANY, DIFFERENCE BETWEEN A 50,000 PSI YIELD STRENGTH HSLA STEEL AND AN 80,000 PSI YIELD STRENGTH STEEL. HOWEVER, PURE DRAWING IS INFREQUENT. IT IS USUALLY FOUND IN COMBINATION WITH STRETCHING AND/OR BENDING.<br><br>STRETCHABILITY DIMINISHES AS STRENGTH INCREASES. STRETCHABILITY OF A 50,000 PSI YIELD STRENGTH HSLA IS ABOUT 85-95% OF ORDINARY COMMERCIAL 1010 STEEL.<br><br>STRETCHABILITY OF AN 80,000 PSI YIELD STRENGTH HSLA STEEL IS ABOUT 75-80% of 1010 STEEL.<br><br>FOR MINIMUM CRACKING AT STRETCHED SHEARED EDGES, THE IMPROVED FORMABILITY HIGH STRENGTH LOW ALLOY STEELS, WITH INCLUSION SHAPE CONTROL, HAVE A DISTINCT ADVANTAGE OVER THE CARBON STEELS AND THE HSLA MATERIALS WITHOUT INCLUSION SHAPE CONTROL. | 0t | FOR BOTH RESISTANCE SPOT WELDING AND FUSION WELDING, IT IS POSSIBLE TO SATISFY DESIGN REQUIREMENTS WITH HIGH STRENGTH LOW ALLOY STEELS FOR THE ENTIRE RANGE OF YIELD STRENGTHS. HIGH PRODUCTION CYCLE TIMES ARE NOT A PARTICULAR PROBLEM WITH ANY OF THE HSLA GRADES. WITH A DESIGN ESTABLISHED, WELD TIP LIFE IS ADEQUATE IN NORMAL PRODUCTION ENVIRONMENTS. GIVEN PROPER ELECTRODE COOLING, ELECTRODE DESIGN, ETC.<br><br>FOR IMPROVED WELDABILITY IN A GIVEN STEEL, THE AMOUNT OF CARBON AND MANGANESE CAN BE REDUCED. FOR EQUIVALENT STRENGTHS, HSLA STEELS PROVIDE BETTER FUSION AND SPOT WELDING CHARACTERISTICS THAN CARBON STEELS OR CARBON STEELS WITH NITROGEN OR PHOSPHORUS ADDED, DUE PRIMARILY TO LESS AMOUNTS OF CARBON.<br><br>THE YIELD AND TENSILE STRENGTH OF SPOT WELDS IN HSLA STEEL IS VERY CLOSE TO THAT OF THE PARENT METAL, ALTHOUGH THE FATIGUE STRENGTH OF THE WELDS IS ONLY MARGINALLY GREATER THAN CARBON LOWER STRENGTH STEELS. |
| Carbon (Structural Quality) | C, Mn, With or Without Added N or P | 40000 | 55000 | 20-21 | | | C & Mn Only 2t<br>With N or P added 1/2t | | |
| Carbon (Structural Quality) | C, Mn and added N or P | 45000 | 60000 | 18 | | | 1½t-2t | | |
| HSLA | Cb and/or V (Semi-Killed or Killed) | 45000 | 60000* | 25 | | | 1t | | |
| HSLA (Improved Corrosion Resistance) | (Proprietary) Cu, Cr, C, Mn, Ni, P and Low Alloy Additions (Semi-Killed or Killed) | 50000 | 70000 | 22 | | | 1t | | |
| Carbon (Structural Quality) | C, Mn, and added N or P | 50000 | 65000 | 16 | | | 2t-2½t | | |
| HSLA | Cb and/or V (Semi-Killed or Killed) | 50000 | 65000* | 22 | | | 1t | | |
| HSLA (Improved Formability) | Proprietary, with inclusion control, with addition of one or combination of Cb, V, Ti, Zr, Si, N, etc. (Killed) | 50000 | 60000 | 24* | | | 0t | | |
| HSLA | Cb and/or V (Semi-Killed or Killed) | 55000 | 70000* | 20 | | | 1½t | | |
| HSLA | Cb and/or V (Semi-Killed or Killed) | 60000 | 75000* | 18 | | | 2t | | |
| HSLA (Improved Formability) | Proprietary, with inclusion control, with addition of one or combination of Cb, V, Ti, Zr, Si, N, etc. (Killed) | 60000 | 70000 | 22* | | | 0t | | |
| HSLA | Cb and/or V (Semi-Killed or Killed) | 65000 | 80000* | 16 | | | 2½t | | |
| HSLA | Cb and/or V, (Semi-Killed or Killed) | 70000 | 85000* | 14 | | | 3t | | |
| HSLA (Improved Formability) | Proprietary, with inclusion control, with addition of one or combination of Cb, V, Ti, Zr, Si, N, etc. (Killed) | 70000 | 80000 | 20* | | | 1t | | |
| | | 80000 | 90000 | 18* | | | 1t | | |

*Should be reduced 5000 PSI when lower carbon req'd.

*Subtract 2% for thicknesses 0.097" and thinner.

*Bend test up to 0.229 inches inclusive—longitudinal specimen. t=test thickness. Also see notes.

**This table is furnished by the Committee of Hot Rolled and Cold Rolled Sheet and Strip Producers and the Committee of Galvanized Sheet Producers, American Iron & Steel Institute.**

5 percent a year.

Looking at trends for particular types of cast material, Commerce Department experts see gray iron and ductile iron castings shipments in 1975 up 5 percent and reaching a record 17.4 million tons, exceeding the record set in 1973 by 2 percent.

Malleable castings shipments, depressed an estimated 6 percent by the automotive industry's lower demands in 1974, are expected to increase 7 percent in 1975 to 1,032,550 tons. This would equal 1973's shipments. Such an increase, however, is predicated on a nearby rebound in automotive demand, which at this point looks highly unlikely.

Steel castings shipments, estimated at 1.9 million tons in 1974, are predicted to increase 5 percent to 2 million tons in 1975.

**ALUMINUM**—With the government's aluminum stockpile now eliminated, and producers' inventories being depleted, the primary aluminum producers will be trying to increase shipments of ingot and mill products by about 2 percent, to 14.8 billion lb, in 1975.

Imports will take on greater importance in the overall supply picture. The year will see a 20 percent increase of imports (by volume), and exports from domestic producers will continue the decline that started in 1974.

Capacity increases of 107,000 short tons in late 1975 and of 317,000 short tons in 1976 are in prospect to bring the domestic industry's annual potential to 5.3 million short tons.

The secondary aluminum industry, aided by the increased emphasis on recycling, will produce about 3 billion lb of material in 1975, a 10 percent increase.

While 1975's aluminum supplies, in total, will be tight and hold down the material's short-

| Atmospheric* Corrosion Resistance | Pertinent Public Standards and Recommended Practice | ADVANTAGES | TYPICAL APPLICATIONS | NOTES |
|---|---|---|---|---|
| 1 | SAE or AISI 1006, 1008, 1010, 1012 | HIGH STRENGTH LOW ALLOY STEEL SHEETS PROVIDE IMPROVED MECHANICAL PROPERTIES, WITH STRENGTHS RANGING BETWEEN STRUCTURAL QUALITY CARBON STEELS AND HIGHER STRENGTH QUENCHED AND TEMPERED STEELS. HIGH YIELD STRENGTHS ARE OBTAINABLE WITH GOOD DUCTILITY (WITH SULFIDE SHAPE CONTROL) IN THE TRANSVERSE AND LONGITUDINAL DIRECTIONS. THERE ARE ALSO ECONOMIC BENEFITS, SINCE STRENGTHS ARE OBTAINED FROM ALLOYING AND CONTROL OF THE HOT ROLLING CONDITIONS. HEAT TREATMENT, BEFORE OR AFTER FORMING, THEREFORE IS NOT REQUIRED. HIGH STRENGTH STEELS PERMIT INCREASED PAYLOADS, IMPROVED DESIGN EFFICIENCY DUE TO LIGHTER WEIGHT POTENTIAL AND SMALLER BEND RADII FOR TIGHTER ASSEMBLIES. HIGHER FATIGUE STRENGTHS AND BETTER NOTCH TOUGHNESS ARE CHARACTERISTIC OF THE HSLA STEELS, AS COMPARED TO THE STRUCTURAL QUALITY STEELS. DEFINITE COST AND WEIGHT SAVINGS ARE POSSIBLE IN A DESIGN, COMPARED TO STRUCTURAL QUALITY CARBON STEEL. | APPLICATION AND CHOICE OF SPECIFIC HIGH STRENGTH CARBON OR HIGH STRENGTH LOW ALLOY (HSLA) SHEET STEEL DEPENDS ON THICKNESS REDUCTION, CORROSION RESISTANCE, FORMABILITY, WELDABILITY REQUIREMENTS, ETC. THESE SHEET STEELS TYPICALLY ARE USED IN APPLICATIONS SUCH AS MOBILE EQUIPMENT, TRUCK BODIES, FRAMES, STRUCTURAL MEMBERS, SCRAPERS, TRUCK WHEELS, CRANES, SHOVELS, BOOMS, CHUTES, CONVEYORS, TANKS, BUSES, FARM MACHINERY, INDUSTRIAL EQUIPMENT, BARGES AND DREDGES, TRANSMISSION TOWERS, MINE AND RAILROAD CARS, AUTOMOTIVE BUMPERS, BUMPER PARTS, CARGO CONTAINERS, MOTOR MOUNTS, TRAILERS, CONTROL ARMS, BOX MEMBERS, CHANNELS, BEAMS, STEERING COMPONENTS, SUSPENSION BRACKETS, AXLE TUBES, PARKING BRAKE LEVERS, TRANSMISSION SUPPORTS, TRANSMISSION FLEX PLATES. | COST OF THE HIGH STRENGTH STEELS CAN RANGE UP TO APPROXIMATELY THIRTY-FIVE PERCENT MORE THAN REGULAR LOW CARBON STEELS, DEPENDING ON STRENGTH LEVEL AND FORMABILITY REQUIREMENTS. HOWEVER, POSSIBLE WEIGHT REDUCTION COULD ELIMINATE SOME OR ALL OF THIS COST.<br>STEELS IN EXCESS OF 42,000 PSI MINIMUM YIELD STRENGTH ARE GENERALLY FURNISHED AS HSLA STEELS.<br>HSLA STEELS ABSORB MORE ENERGY PER UNIT WEIGHT THAN PLAIN CARBON STEELS. RELATIVE TO REGULAR LOW CARBON STEEL, IT IS POSSIBLE TO SAVE WEIGHT WHEN DESIGNING FOR IMPACT, THROUGH USE OF HSLA STEELS FOR ENERGY ABSORBING COMPONENTS. DESIGNED FOR HIGH RATES OF STRAIN, HSLA STEELS GENERALLY CAN MEET REQUIREMENTS IN KILLED STEELS. THE IMPACT PROPERTIES ARE MORE UNIFORM THAN IN SEMI-KILLED OR CAPPED STEELS.<br>NOTCH TOUGHNESS INTEGRITY IS GREATER WITH KILLED STEELS, DUE TO FINER AND MORE UNIFORM GRAIN STRUCTURE, THAN SEMI-KILLED OR CAPPED STEELS.<br>COLD BEND RADII ARE BASED ON BEND TEST IN ASTM SPECIFICATION A370. THESE RATIOS APPLY TO BENDING PERFORMANCE OF TEST SPECIMENS. WHEN SHEET STEEL IS SUBJECT TO BENDING IN A FABRICATING OPERATION, MORE LIBERAL BEND RADII MUST BE USED.<br>FOR TRANSVERSE BENDING, THE VALUES WOULD BE APPROXIMATELY 1/2T to 1T GREATER, EXCEPT IN THE CASE OF THE GRADES WITH INCLUSION SHAPE CONTROL, IN WHICH THE RADII ARE APPROXIMATELY ZERO TO 1/2T GREATER.<br>BY DEFINITION, (ASTM A 568), A SHEET IS DEFINED BY THE FOLLOWING TABLE:* |
| 1 | Negotiable between producer and consumer. | | | |
| 1 | ASTM A570 Grade D C and Mn Only<br>N or P added<br>Negotiable between producer and consumer. | | | |
| 1 | Negotiable between producer and consumer. | | | |
| 1 | ASTM A607 SAE J410C | | | |
| 2 or More<br>4 or More | ASTM A606 Type 2 and Type 4 (Weathering) | | | |
| 1 | Negotiable between producer and consumer. | | | |
| 1 | ASTM A607 SAE J410C | | | |
| 1 | ASTM XXX* | | | |
| 1 | ASTM A607 SAE J410C | | | |
| 1 | ASTM A607 SAE J410C | | | |
| 1 | ASTM XXX* | | | |
| 1 | ASTM A607 SAE J410C | | | |
| 1 | ASTM A607 SAE J410C | | | |
| 1 | ASTM XXX* | | | |
| 1 | ASTM XXX* | | | |

**DIMENSIONAL CLASSIFICATIONS FOR HOT-ROLLED CARBON SHEET STEELS**

| Nominal Thickness, inches | Width, inches: Over 12-48, inclusive | Width, inches: Over 48 |
|---|---|---|
| 0.045 to 0.179 | Cut lengths and coils | Cut lengths and coils |
| 0.180 to 0.229 | Cut lengths and coils | Coils only |
| 0.230 to 0.500 | Coils only | Coils only |

**DIMENSIONAL CLASSIFICATIONS FOR HOT-ROLLED HIGH-STRENGTH LOW ALLOY SHEET STEELS:**

| Nominal Thickness, inches | Width, inches: Over 12-48, inclusive | Width, inches: Over 48 |
|---|---|---|
| 0.071 to 0.179 | Cut lengths and coils | Cut lengths and coils |
| 0.180 to 0.229 | Cut lengths and coils | ——— |

*Adding 0.20% (minimum) copper will provide approximately two times the atmospheric corrosion resistance of carbon steel.

*ASTM specifications currently under development.

*SIZE LIMITATIONS SHOWN MAY VARY AMONG INDIVIDUAL PRODUCERS.

range growth rate, growth in the long-haul is expected to be 6 percent a year, rising to about 20.6 billion lb by 1980.

**ZINC**—With 41 percent of the country's zinc usage accounted for by die castings (for which the overall demand is fluctuating widely) and with domestic zinc metal production falling sharply for five years before 1974 when it made a small turnaround, consumption by zinc users in 1975 is nevertheless expected to be at the 1973 record level.

Demand, however, will depend heavily upon the availability of competitively priced material, including plastics.

Zinc in galvanized steel is the second largest use of the metal, and somewhat smaller usage in this direction is in prospect for 1975 because of the steel industry's shutdown of some continuous galvanizing lines.

Domestic zinc supplies are expected to remain short in part because of expected exhaustion of the government's stockpile in mid-1975.

Premium-price imports are making up part of the domestic shortfall, with prices as high as 90 cents per lb compared with domestic material in the 35-36 cent/lb range.

Demand for zinc is expected to grow at an annual rate of 3 percent to 1980, but this growth may be tempered by the supplies and prices of such competing materials as aluminum and magnesium for die casting, and plastics. Imports will continue to figure in the supply equation, although U.S. capacity is due to be expanded by perhaps 300,000 tons by 1980.

**COPPER**—Domestic production of primary copper is expected to reach a record of 1.75 million tons in 1975, up 13 percent from 1974; and consumption of copper-base mill products will climb an estimated 5 percent.

Materials experts in the Commerce Department look for "a relatively balanced supply/demand situation" in 1975, and a more normal price outlook after last year's erratic price fluctuations in the world markets.

Domestic supplies were augmented last year by elimination of the government's stockpile, and more domestic material will be mined and smelted this year to bring refined copper output from domestic ores to a record level. Total supply, including imports, is anticipated to reach 2.6 million tons and demand to hover at 2.45 million tons.

Through 1980, the long-term growth pattern for copper is expected to amount to 4.3 percent a year, and price increases have stimulated opening of additional domestic mining and refining facilities.

**PLASTICS**—Tight supplies and price increases will be prevalent throughout the chemical and allied products industries in 1975, according to the Commerce Department's outlook report.

Looking at plastics specifically, the report anticipates a 10 percent increase in plastics production in 1975 to 32.9 billion lb. New pro-

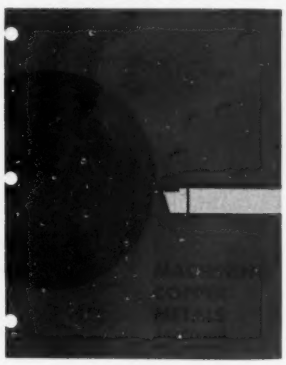
duction facilities will be on stream although the supply of adequate feedstocks will be the limiting factor.

Imports of plastic materials are holding to about 4-5 percent of domestic consumption, and amount to about one-seventh of the value of the domestic producers' exports.

Although the plastics and petrochemical industry accounts for only 6 percent of the country's domestic consumption of petroleum and natural gas, the heavy demands on these raw materials for heating and other energy uses makes highly doubtful an ade-

# USEFUL LITERATURE

**Practical suggestions for machining copper,** brass,



bronze, and nickel silver, including cutting tool materials and feeds and speeds, are presented in a 38-page technical brochure. **(Anaconda Co.)**
*Indicate No. 664 on card*

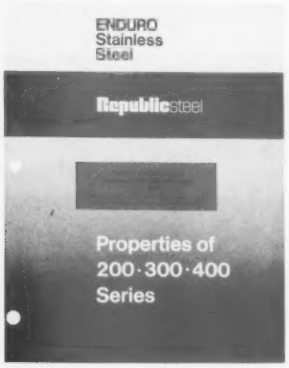
A 12-page technical brochure **"Alloy Steel Analyses"** lists AISI, SAE, and SAE "Ex-

perimental" steel analyses. **(Copperweld Steel Co.)**
*Indicate No. 665 on card*

**A buyers' guide in easy-to-use foldout chart form** lists all the necessary facts to help

select the best and most economical **stainless steel** for every application. **(Joseph T. Ryerson & Son)**
*Indicate No. 666 on card*

Several pieces of current literature are available from **Republic Steel.** For an 8-page brochure giving chemical, physical, and mechanical



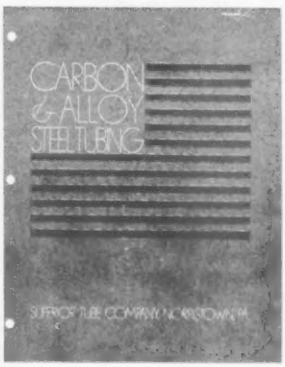

**properties of the 200, 300, and 400 stainless series** *indicate No. 659 on card.* For a 12-page brochure on **cold finished alloy steel bars** *indicate No. 660 on card.* For a 20-page brochure on cold finished **free-machining steels,** *indicate No. 661 on card.* For a 24-page brochure on cold finished **special sections** *indicate No. 662 on card.* For a 4-page brochure on **high strength low alloy steels** for forming complex shapes *indicate No. 663 on card.*

Three items are offered by **Carpenter Technology:** For a 16-page brochure listing **stainless machining bars** that bring economies to automatic

screw machine shops *indicate No. 667 on card.* For a **pocket-size slide selector** giving useful information on machining 23 stainless grades *indicate No. 668 on card.* For a 14-page brochure on **Die Steels of the Seventies** *indicate No. 669 on card.*

Two publications dealing with selection of engineering resins are available from **Celanese Plastics Co.** For the 26-page **"What You Always Wanted to Know About Engineering Resins"** *indicate No. 670 on card.* For a 16-page brochure dealing with **the properties of engineering structural foam** *indicate No. 671 on card.*

Three publications presenting technical information on close tolerance, small diameter tubing are available from **Superior Tube Co.** For a 42-page booklet, **"Carbon & Alloy Steel Tubing,"** describing **cold-drawn car-**




**bon and alloy steel tubing** and giving selection and application information, *indicate No. 672 on card.* For 62-page **"Stainless Steel Tubing,"** with chemical and property information on various types of stainless, *indicate No. 673 on card.* For 40-page **"Nickel and Nickel Base Alloy Tubing,"** *indicate No. 674 on card.*

A collection of brochures outlining **ready-to-use production epoxies** for adhesives,

potting, and encapsulating applications, in a plastic binder, is available from **Hardman Inc.**
*Indicate No. 675 on card*

A 8-page brochure describing **new opportunities in aluminum powder metallurgy is available from Powder Metallurgy, Inc.**
*Indicate No. 689 on card*

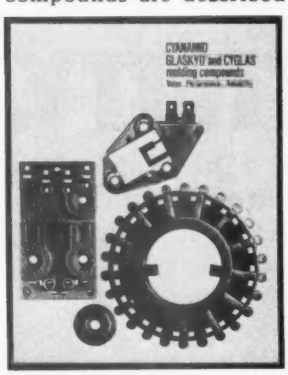
quate supply for this segment of the market. Consequently, price increases and shortages are expected to somewhat throttle the use of plastics for disposable, low-cost items. Available resins will tend to be channelled into engineered applications, where better use of resins with extenders can be made.

The Commerce Department, however, is foreseeing tremendous growth of plastics production by 1980. It anticipates production of over 50 billion lb providing feedstocks, including more coal-derived material, can be obtained. ■

**Coil coated steels** and some helpful hints on fabricating are presented in a 28-page

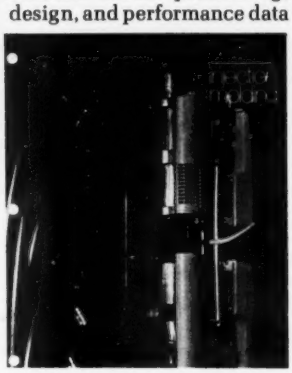
brochure offered by **Armco Steel Corp.** *Indicate No. 676 on card.* For a 22-page brochure on Armco **hot-rolled and cold-rolled steels** *indicate No. 677 on card.* Also offered is an 8-page **product data brochure** illustrating products to show superior drawing quality of Armco I-F steels. *Indicate No. 678 on card.*

**Molding compounds for intricate, plastic precision parts** are described in a 24-page brochure offered by **American Cyanamid Co.** Galskyd and Cyglas molding compounds are described




and a troubleshooter's guide is presented. *Indicate No. 679 on card.* Also offered is a 16-page brochure on **polymers for thermoforming,** *indicate No. 680 on card,* and a 12-page brochure on **polymers for injection molding,** *indicate No. 681 on card.*

**A 36-page Noryl resin injection molding brochure** offered by **General Electric Plastics** covers processing, design, and performance data



on the company's plastic products. *Indicate No. 682 on card.* Also offered is a 56-page **thermoplastic resins design manual** presenting complete design, fabrication, and performance data. *Indicate No. 683 on card*

**A 16-page designer's guide to structural foam** compares the properties of structural foam with those of wood, solid plastics, metal, and concrete, and reviews design considerations. **(Union Carbide Corp.)** *Indicate No. 684 on card*

A 4-page brochure on **cold finished carbon steel bars** including a chart on characteristics and machinability is offered by **Jones & Laughlin Steel Corp.** *Indicate No. 685 on card.* J&L also offers a series of one- and two-page data sheets on **a number of types of stainless steels.** *Indicate No. 686 on card*

**Design ideas, rubber property definitions, and suggested uses** for nine groups of

elastomers are presented in a 32-page bulletin by **B.F. Goodrich Chemical Co.** *Indicate No. 687 on card.* Also offered is a 12-page bulletin presenting physical and chemical properties of the company's **vinyl, ABS polyurethane, and acrylic materials.** *Indicate No. 688 on card*

A 40-page guide which presents a broad range of **materials charted for selection by industry classification** is available from **Dow Corning.** Includes rubber compounds, moldmaking materials, adhe-

sives, potting materials, etc. *Indicate No. 690 on card.* Also offered is 14-page brochure describing cost and reliability of **formed-in-place gaskets** using Silastic sealant. *Indicate No. 691 on card*

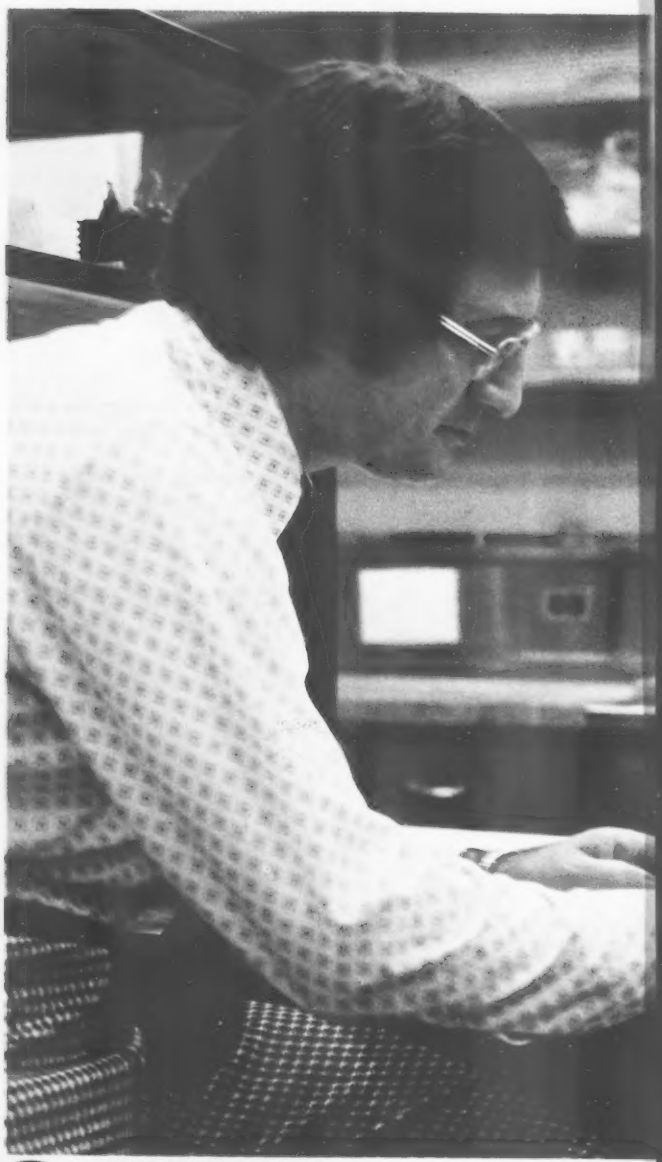
An 8-page **nylon gear design manual** is offered by **Polymer**

**Corp.** *Indicate No. 692 on card.* Also, a 6-page foldout brochure outlines the company's extensive line of **injection molding resins.** *Indicate No. 693 on card*

A 24-page **value analysis guide** to the selection of wire

**for cold forming processes** is available from **United States Steel.**
*Indicate No. 694 on card*

Corrosion-resistant, heat-resistant, and wear-resistant high-performance **alloys for chemical processing equipment** are described in a 4-page brochure by **Stellite Division, Cabot Corp.**
*Indicate No. 695 on card*



# HOW THIS "LITTLE BLACK BOX" FROM U.S. STEEL IS IMPROVING SHEET STEEL PRODUCTIVITY.

A worker in a U.S. Steel mill inserts three samples of sheet into an instrument about the size of a lunch box.

Numbers flash on the readout screen. Within minutes, he can tell how this steel will perform in the customer's deep-drawing application.

This unique device, called MODUL-r̄, came out of a joint study some years ago... when scientists from U.S. Steel and a major automotive company discovered a correlation between drawability and an elastic property of steel called Young's Modulus.

Before the "little black box," MODUL-r̄, it took three hours of special tension testing with highly trained personnel to measure the drawability of a single sheet. Unfortunately, the measurement of Young's Modulus was hardly suited for production runs because of the sophisticated equipment required.

So two senior research engineers at our Monroeville research center, Tom Johnson, Jr. and Peter Mould, developed and patented this "little black box" that measures the Young's Modulus of a sample in several seconds.

Today, MODUL-r̄ is used in every U.S. Steel sheet mill. It's rugged, insensitive to vibration, and can be operated by non-technical people. In 5 minutes, instead of hours, it can predict the drawability and earing tendency of the sheet we're rolling with scientific precision.

It's helping our mill metallurgists adjust our processes to achieve optimum drawing qualities in our steel. And it's helping customers improve their own productivity... by reducing costly fractures, or rejects resulting from the use of steel of low drawability.

In fact, MODUL-r̄ is such a good idea, we're making it available, under license to Control Products, Inc., for other steel producers and sheet users or tool-and-die makers who want to diagnose breakage problems or make more productive use of steel sheet.

U.S. Steel people make the difference between our products and everybody else's.

Our operating, sales, marketing and metallurgical people are out in the field as much as possible—testing, evaluating, solving problems and our research people like Tom and Peter are backing them up with new advances and techniques.

United States Steel,
Pittsburgh, Pa. 15230.

USS TRADEMARK **United States Steel**

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The Ingersoll-Rand
Approach to Materials Handling

# FOR PRODUCTIVITY AND SAFETY—CHECK YOUR OVERHEAD LOAD HANDLING

BY: L. Smetana, Marketing Manager, Materials Handling
D. Kushner, Sales Manager, Overhead Systems

Are your air hoist operators taking longer every day to complete basic load handling chores? Maybe it's not the operator's fault. Maybe you have "tired" hoists. If you do, you're losing production and payroll dollars because more money is buying less output. Your profit is suffering. And so is safety.

Likewise you may also have a complete handling system which is sluggish. And if you don't have an overhead system, now's the time to consider one.

Our studies indicate that many air hoists in use today are operating at 30 percent and more below their rated efficiency. If you have 10 such units, you're paying $18,000 for non-productive hoist operations. Here's why. Those same studies indicate the average hoist in production service is used 60 percent of the operator's working time. If the operator's annual wages, including fringe benefits, average $10,000, you have:

10 x $10,000 x .60 (use factor)
x .30 (inefficiency factor) =
$18,000

Only through a program of regular inspection, testing, and maintenance on your air hoists will you be able to keep them operating at optimum efficiency. All components of your system should be checked: your compressed air system that drives the hoists, the air motors, the brake system, the wire rope or chain, the scheaves, drums, trolley wheels, and hooks.

The trouble-shooting check list such as the one shown will help to identify deficiencies in your hoist or air system that can decrease air hoist efficiency. An accurate maintenance log should be kept on each hoist in your shop.

Your inspection procedure should include a frequent check (daily to monthly intervals) of all mechanical equipment; air and hydraulic systems, hooks, chains, ropes, brakes, and slings for excessive wear. The periodic inspection (1 to 12 month intervals) should include checks for cracked, deformed or corroded members, loose bolts or rivets, worn, cracked, or deformed parts, such as pins, bearings, shafts or gears. Reliable manufacturers of hoists are as concerned with safety in your plant as you are. Their maintenance instructions and repair parts lists will be of significant value to you. Make sure you have it and to insure proper and safe operation, follow their maintenance recommendations and obtain replacement parts from the original manufacturer.

Your program should also include a scheduled replacement of old hoists with new ones, not only to improve your productivity, but to insure safety. A hoist will eventually reach a point where it is uneconomical to repair it to bring it to an acceptable level of operating efficiency and safety.

| | Air Leakage | Air Strainers Clogged | Air Pressure Too Low | Dirty Air | Water in Air | Incorrect Lubrication | Insufficient Lubrication | Hose Too Small | Long Vanes | Worn Vanes | Rotor Rubbing | Worn Bearing Plates | Worn Valve Seat | Throttle Pin Sticking |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Motor Won't Run | | X | X | | | | X | | X | | X | | | |
| Lack of Power | X | X | X | | | X | | X | | X | X | X | | |
| Speed Too Low | | X | X | | | | | X | | | X | | | |
| High Air Consumption | X | | | | | | | | | X | | X | | |
| Excessive Vane Wear | | | | X | | X | X | | | | | | | |
| Excessive Bearing Wear | | | | X | | X | X | | | | | | | |
| Rusting of Parts | | | | | X | X | X | | | | | | | |
| Delamination of Vanes | | | | X | X | X | | | | | | | | |
| Vanes Chipping | | | | X | | X | X | | | | | | | |
| Motor Continues to Run, Throttle Off | | | | | | | | | | | | | X | X |

Air Motor Troubleshooting Checklist.

A moving air logic control system may be retrofitted to any piston hoist in our line that provides lifting capacities from 500 lbs. to 10 tons. The system eliminates solid state controls, potential electric shock and spark-induced explosion hazards. One power source, compressed air, feeds both the hoist controls and the hoist's air motor. The system may be programmed to provide semi-automatic or completely automatic hoist operation after manual initiation of a cycle.

To maximize productivity and profits, use your "air space" to replace existing but less effective handling procedures. An overhead system which includes a bridge or jib crane, the hoist and the proper handling fixture or grab should be considered whenever possible. Why? Overhead systems do not take up the aisle space required for lift trucks, they are less costly to maintain, and overhead systems are usually one-man operations, while other methods may require two or more men.

A simple overhead system can usually be written off in six months or less, and the more sophisticated systems will pay back in a matter of a year or two at the most, based on improved efficiency.

In most cases an overhead system is easy to operate. No special operators or complicated training procedures are required.

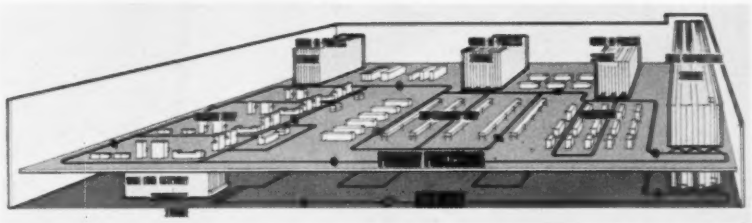
Overhead systems are also safer to use—built in are proven design, construction and performance features that meet or exceed present safety standards. Not only does the overhead system free the worker from backbreaking labor, but it moves goods from station-to-station with greater ease, saving time and increasing production.



INDICATE NO. 233 ON BUSINESS REPLY CARD

# Formulating a BHP Basic Handling Policy

The materials handling equipment manufacturers assert that the materials handling area is the last great frontier for industrial cost savings. With the MH function averaging 35 to 40 percent of every production dollar in many cases, they point out that a 10 to 20 percent improvement or more often can be made by incorporating new handling techniques—much more than usually can be obtained with new production equipment.



**With Kenway Inc.'s "Islands of Automation," work-in-process inventories are compressed into high-density automated storage modules, resulting in significant gains in valuable production floor space**

These equipment manufacturers have some materials handling basics, and the following list contains their 10 most stressed points. An acronym for the concepts they recommend would be BHP—Basic Handling Policy. As the opposite of a brake horsepower test, which sees if a device can be stopped from moving, our BHP would get an organization moving materials more economically. The BHP rules:

**1. Keep the product moving.** Storage requires space and space costs money. When storage is required, design the system so the product flows smoothly into and out of storage. Kenway Inc., a manufacturer of storage/retrieval systems, has named its version of this concept "Islands of Automation."

This system compresses work-in-process parts inventory into one or more high-rise storage/retrieval systems for a gain in valuable production floor space. Small parts, subassemblies, tools and even finished goods can be stored in satellite high-rise storage structures.

Other storage/retrieval system manufacturers offer similar concepts, as for example the Rohr system at the Ford Tractor Plant in Romeo, Mich. (PRODUCTION, October, 1974, p. 84).

**2. Once around is enough.** Along with the concept of keeping the product moving is the need to eliminate backtracking. Extra moves only cost money; there is no extra value gained.

**3. Let machines pace the operation.** Industrial robots or universal transfer devices allow machines to work at full capacity. Manually paced machines are at the mercy of the inherent inefficiencies of a human being.

**4. Formulate a product protection plan.** Too often an expensive part is damaged in a handling operation, especially if it's manual. Containerize parts or lock them into place by straps. It has been proved that not only does a product get damaged when it is carried in an unstable condition but overall productivity decreases as well. The "Islands of Automation" technique works well in this case for two reasons: A worker has no access to the item in process unless it is at his particular work station; and he loses no time looking for material to work on.

**5. Avoid phlebitis of the aisles.** Traffic aisles are the main arteries of material flow and must be kept clear. If OSHA didn't exist, this still should be a basic rule on economic grounds.

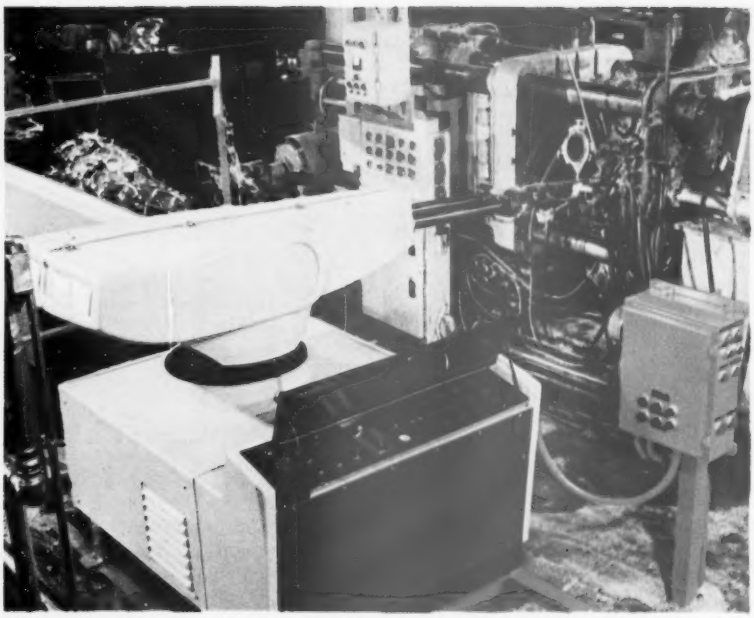
**6. Use mechanical rather than manual methods.** There are many low-cost handling devices for making simple lifts. In addition to avoiding strained backs, hernias, etc., and their cost, such devices permit any operator regardless of age, sex or health to be effective.

**7. Use your cheapest energy —gravity.** There are many types of gravity conveyors that can be used in low-volume operations.

**8. Test before storage.** Storage costs money and storing a commodity that's later scrapped is a total waste.

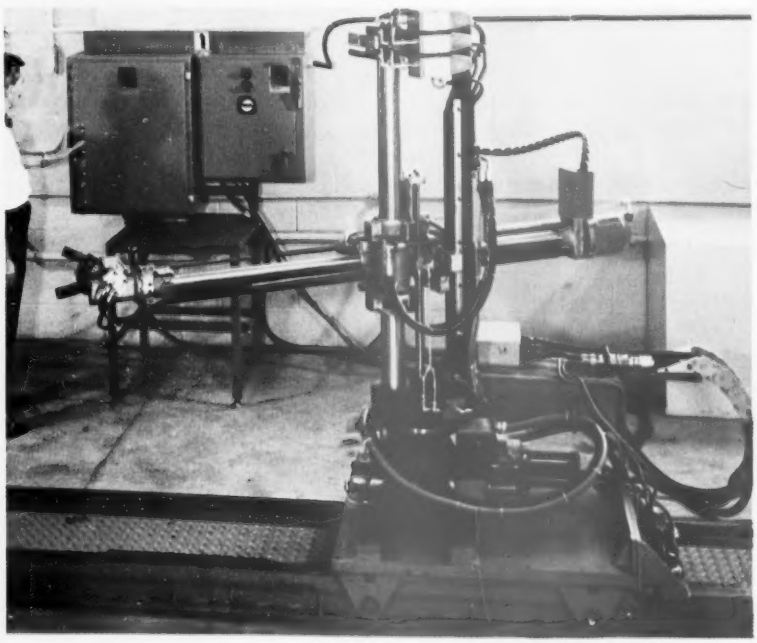
**9. Treat scrap materials as a commodity.** Such scrap is hazardous and should be removed from manufacturing areas as quickly as possible. It should be channeled to a central processing location and sorted according to value. Often, some form of compaction device can form scrap into unit loads for easier handling, higher value, and space conservation.

**10. Think safety first and always.** OSHA and just plain common sense dictate that safety is of prime concern. The arm or hand of a



**This Unimate "industrial robot" easily removes parts in a diecasting operation, without any concern for the environment. Such devices also allow machine pacing rather than manually paced by a worker**

**Getting that extra step, this Versatran "industrial robot" rides cart between work stations**



robot device may be expensive, but it can always be replaced. Consider isolating the operation and using a handling device for machine loading instead of clothing a worker in expensive protective garb (which could include safety glasses, respirators, air shields, ear muffs, etc.).

Materials handling plays second fiddle far too often in new equipment installations. The new equipment is to improve productivity, and so is material handling equipment. By using a BHP, a good operation can be even better.

## THE ROBOTS ARE COMING

With systems analysis taking hold in the materials handling field, many companies are finding they have neglected the "bread and butter" area of savings—material handling at the workplace. No matter how efficient the production equipment is, the operation will still be paced by the flow of material through it.

The need for an operator to call a department lift truck driver to transport material to and from his machine can often create periods of downtime of a half an hour or longer. In one manufacturing plant, studies indicated that upwards of four hours were spent just looking for the materials required for a particular operation.

Other costs and even injuries to the operator occur from parts being dropped from loading and unloading the parts into the machine. If during assembly operations, tools are not within easy reach of the worker, time is wasted through excessive body motion. Just a simple tool balancer may save untold dollars by allowing easy access to the tool.

However, it is the industrial robot that will revolutionize workplace materials handling. Prices range from $15,000 for the most basic machines up to $100,000 for sophisticated designs. Robot capabilities have become commonplace in many industries. A typical example is a mold spraying operation where the robot program not only controls the spray of a contour mold, but indexes the mold, and even periodically cleans the spray nozzle by immersing it in a solvent bucket.

In most applications, the robot can handle heavier loads more accurately and at higher speeds for longer periods of time than its human counterpart. Additional

advantages of the robot are:

1. Automatic pacing of manufacturing operations.

2. Environment is not a problem. Robots can operate in the dark without heating or cooling and are not affected by polluted atmospheres.

3. Operations can be scheduled without regard to human frailties. No employee training is required, and sex, seniority, and vacations are no longer problems.

4. A robot works according to the dictates of the machine it feeds and is not dependent upon human factors, shift changes, etc.

5. Carelessness is eliminated, resulting in an increase in product quality.

The automotive industry is the foremost user of robots. But by 1980, use of robots by non-automotive manufacturers is expected to shrink the automotive component of the market to 24 percent. Predictions are that the market for advanced industrial robots may reach one billion dollars by 1985; and, from the handful of suppliers that now dominate the industry in the United States, over 20 more will be entering the field shortly.

Endorsement of the robot's success is a statement by George Munson, Jr., marketing manager of Unimation, Inc.: "While the automotive industry has always been one of our prime customers, their market is currently softening due to the sales downturn.

"However, the urgency to reduce costs in other manufacturing industries has led to an intensive study of the robot's potential use, especially in metalworking industries such as diecasting and forging. Because of this factor, we believe the diversification of robot usage will yield one of our best years in sales."

**Other Workplace Developments.** Not all workplace handling operations require automation. Quite often a sophisticated handling device can greatly enhance human capabilities while being dependent on the mental prowess of an individual. General Electric has developed a handling device that extends the operator's reach and amplifies his strength while maintaining a level of response that approximates the operator's dexterity by duplicating his body motions.

An example of the company's "Man-Mate" industrial boom's potential is found in a forging operation at TRW's Airfoil Division, Cleveland, O. The operator controls the forging operation from an "armchair" alongside of the boom.

From a control panel at his armchair, the operator not only moves the part, but controls opening and closing the door of an electric furnace, and operating a 12,000-ton Erie forging press and a 500-ton trim press. The boom is controlled through a single handgrip with its motions duplicating and amplifying the natural arm movements of the operator. With this device, less than 5 lb of force from the worker can move loads weighing from 40 to 4000 lb.

**Techniques Abound.** An addition to conveyors used for transporting parts between machining or assembly operations is the latest generation of shuttle cars. Employing a variety of power sources, most of them allow a smooth movement without a jerky stop and go action. The air-film pallet or caster has become quite common in industry. However, some of the more recent developments follow some kind of steel track or rail. Power sources include chain drives and on-board battery motors.

Two of the more unusual devices are SI Handling Systems,

*(continued on page 119)*

**Only one man is used for operating all components of this forging system at TRW, Cleveland, Ohio. Comfortably seated in his "armchair" the operator controls movement of the part as well as the operation of the furnace door, forge and trimpress (in the lower righthand corner)**

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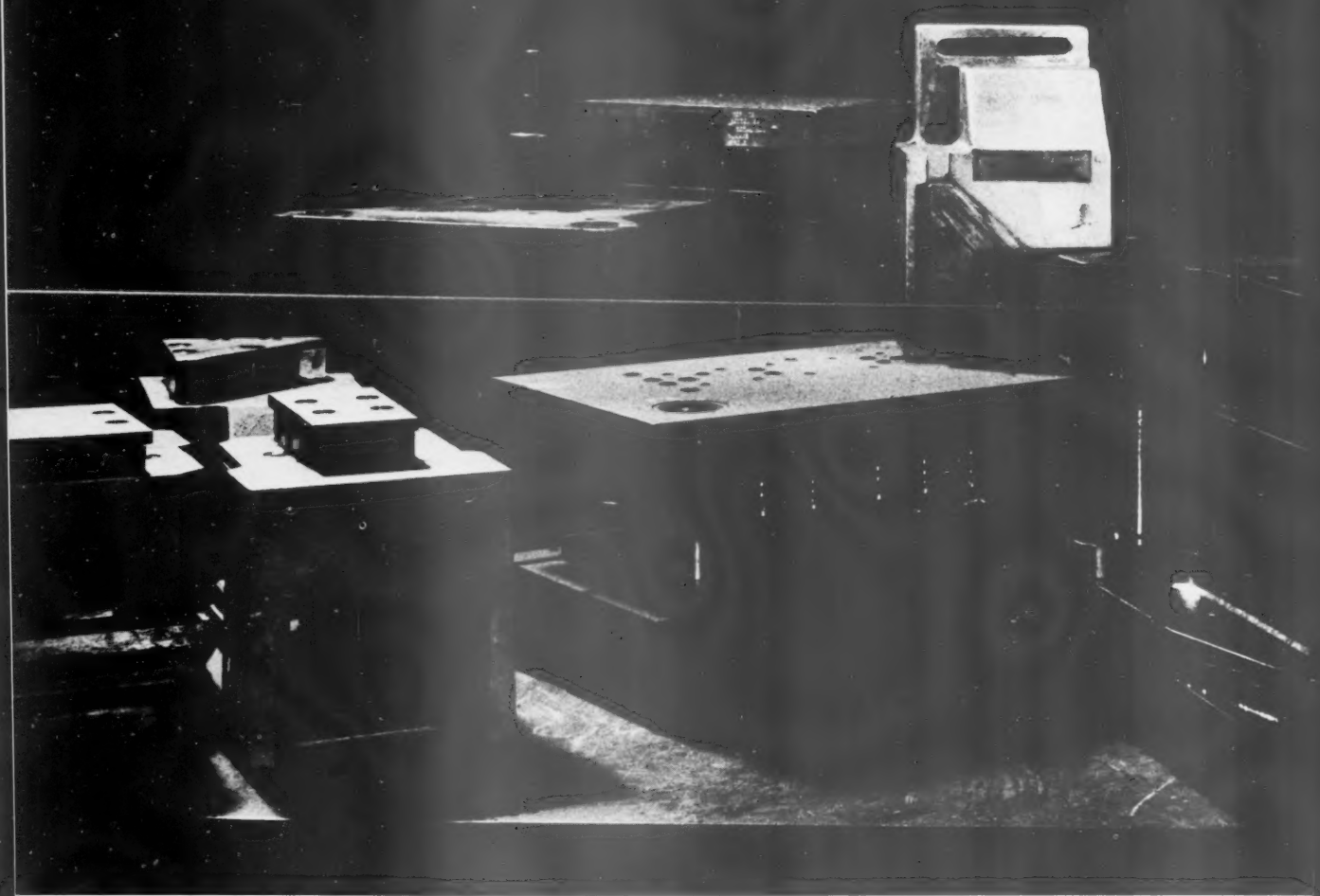
INDICATE NO. 234 ON BUSINESS REPLY CARD

# "What do you mean to help you



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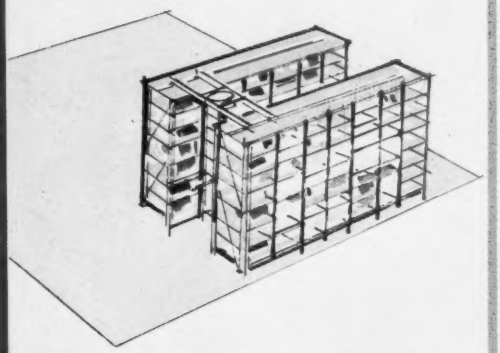
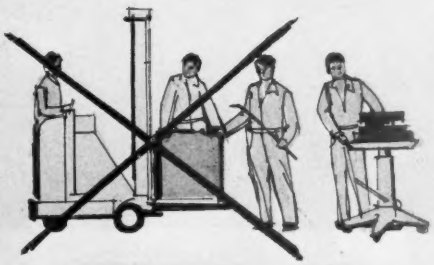
# Cost reduction opportunities with a Stanley-Vidmar STAK System



- 13 foot high racks provide vertical storage.
- Removable pallet shelves are adjustable on 4 inch centers. Custom sized openings can be created, thereby achieving extremely high density and maximum utilization of the cube.
- 6½ foot aisle.
- 228 square feet of floor space required for entire system. (*Includes* 6½ foot aisle).
- Compact system that can be located almost anywhere. Press room, die shop, tool crib, etc.
- System contains captive lifting unit.

**Personnel:**



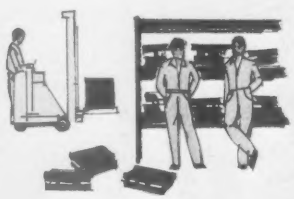
- The captive lifting unit eliminates the need for a lift truck and its operator.
- The die and pallet are removed as one unit, eliminating the need to lift, slide, or manhandle a die onto forks by two or more men.
- The STAK System is a total one-man operation from pallet (shelf) to press!

**Safety:**

- No lifting or straining to remove dies.
- Less accidents and lost time. Reduced possibility of crushed fingers or toes.
- Built in high intensity lighting allows clearer visibility.
- No climbing (OSHA violation).

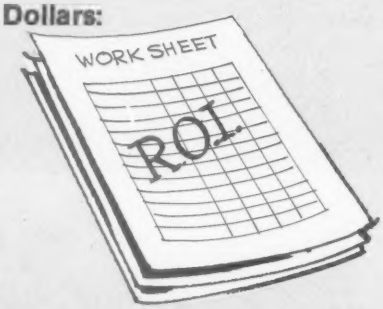
**Time:**

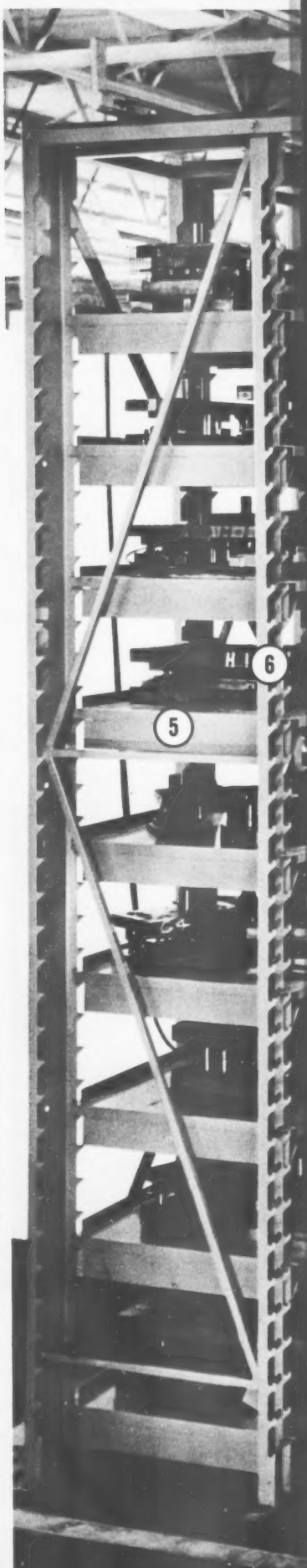
- Average retrieval time . . . 150 seconds or less!
- Self-contained system. No waiting for a lift truck or additional help.

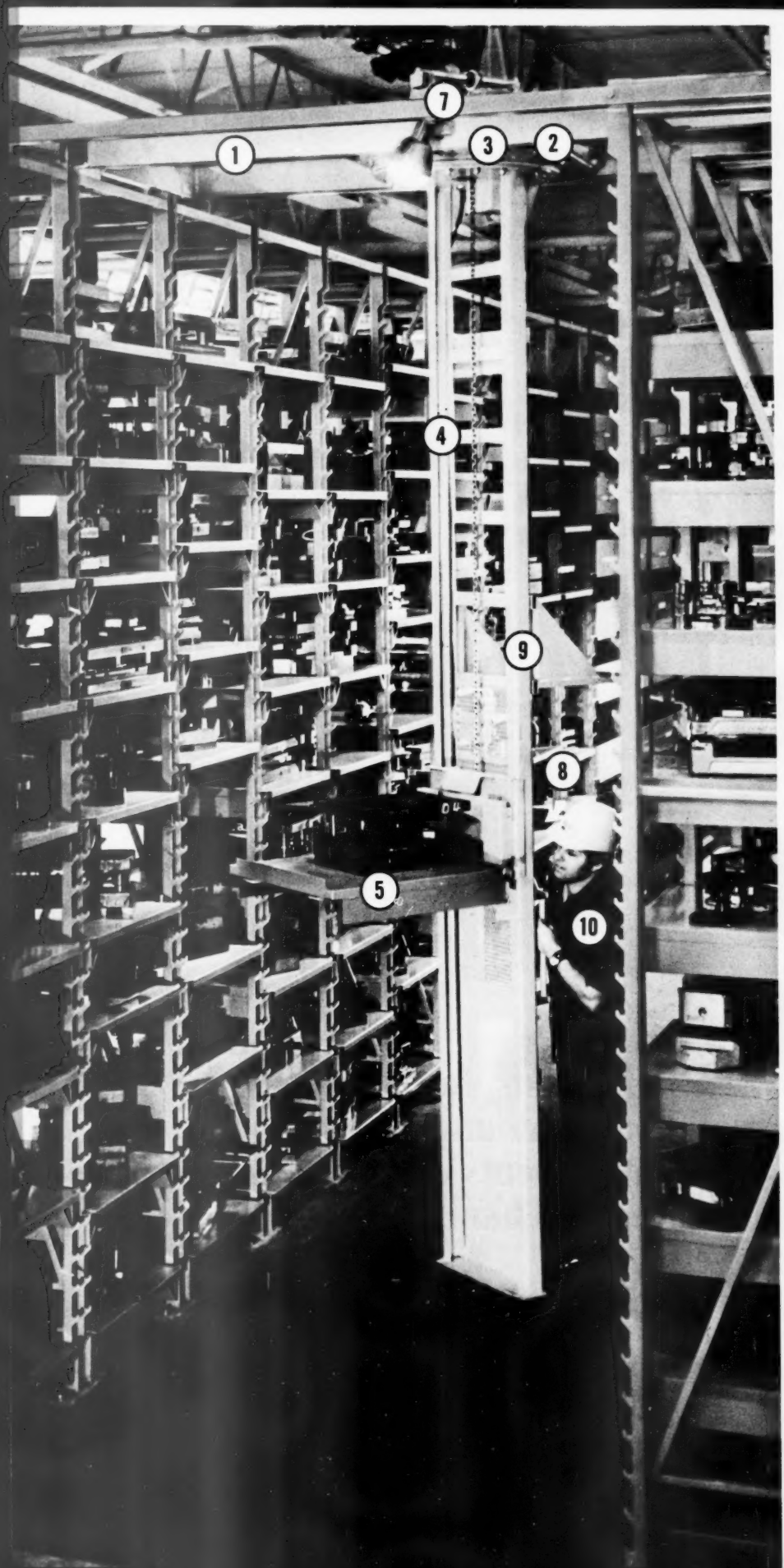


- Entire pallet is removed.
- All dies are equally accessible.
- Less locating time, retrieval time, down time. No longer a two or three man retrieval operation.
- Pallets can be clearly labeled for easy location and fast retrieval.

**Dollars:**






# Here's how it works...

**1. Overhead Bridge**
The overhead bridge section rides on rails mounted on the racks. The operator easily moves the mast along the aisle.

**2. Trolley Section**
The trolley section allows the mast to move left or right, giving the operator easy access to either side of the racks.

**3. Turntable**
The turntable allows the operator to rotate the mast up to 360°. All pallets are completely accessible.

**4. Rugged Heavy-Duty Steel Mast**
It is engineered to easily carry up to 1000 pounds. The electric hoist elevates and lowers the lifting portion on the mast.

**5. Removable and Adjustable Pallets**
They rest on notches in the rear, and positively locate and engage hooks at the front of the rack. They are adjustable at 4 inch increments permiting high density storage and maximum utilization of the cube.

**6. Heavy Duty Steel Racks**
Easily assembled, they become the sturdy frame for the entire unit. Average assembly time for standard unit is 50 man-hours. The entire unit is free standing and includes built-in leveling devices.

**7. Built-in High Intensity Lighting**
Lights are attached to the bridge and travel with the mast providing illumination where it's needed.

**8. Controls**
The "on-off" key prevents unauthorized personnel from operating the STAK System. Conveniently located push buttons operate the vertical movement of the lifting portion of the system.

**9. Safety Shield and Viewing Port**
A heavy duty steel overhead shield protects the operator. The plexiglas viewing port gives the operator full visibility of the pallet.

**10. ONE MAN!**
One man operates the entire system without ever touching a pallet! His hands touch only the controls when either retrieving or replacing a die.

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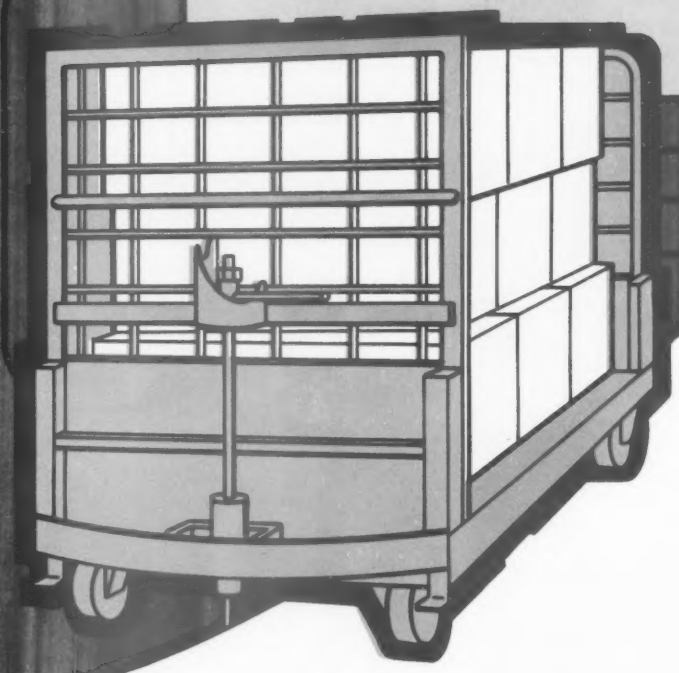
# a quarter million feet of FMC Slide-Tow® systems sold...



**means lower initial costs, faster payout and minimal manpower and maintenance requirements . . . for a lot of smiling material handling systems buyers.**

**Maybe you should join the group.**

**For solutions to your specific material handling problems contact:**
**FMC Corporation**
**Material Handling Systems Division**
**Colmar, Pennsylvania 18915**
**Telephone (215) 822-0581**

FMC Material Handling

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INDICATE NO. 235 ON BUSINESS REPLY CARD

**Not all station-to-station handling need be robotized. The carts on this SI Handling Systems' design, can be easily shunted to any work station**

*(continued from page 109)*

Inc.'s "Cartrac" and Litton UHS's "Machine Shop Mole." The Cartrac unit gets its power from a wheel on the bottom of the shuttle cart contacting a rotating tube between the tracks. The angle of the wheel against the spinning tube determines the speed of the cart.

The "Mole" is a two-car system with one car, the "Mole," riding along with the other, the "TransfeRobot." When this unit reaches a storage location or staging lane, the Mole leaves the TransfeRobot and rides its own set of tracks to the load. A lifting mechanism allows the Mole to pick up the load and then return to the main carrier. Power to the Mole is supplied by an umbilical cord from the TransfeRobot. The entire system is ac-powered similar to a stacker crane. A buss alongside the track provides power to the TransfeRobot.

Exotic new developments are not the only thrust for the wave of the future. Edward Carney, sales and engineering manager of Chain Conveyor Division, Acco, notes, in addition to new developments, the advantages of traditional power-and-free conveyors and their extension to subfloor towlines with accumulating tow carts. "We have furnished a system that includes a successful marriage of a subfloor towline system, tow carts, and a series of machine tools, all directed by computer control," he explains.

## BETTER COMMUNICATION—AN IMPORTANT BONUS

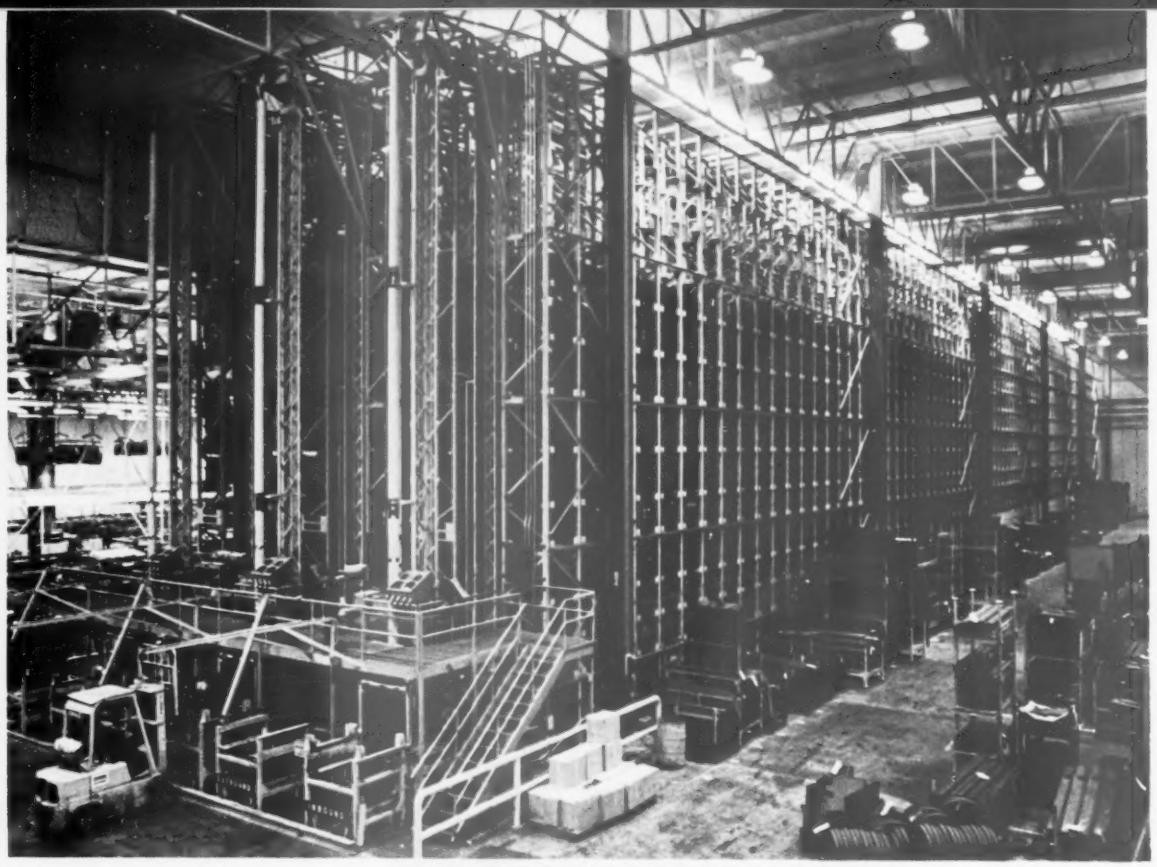
Many manufacturing managers are pleasantly surprised when they discover that an adjunct to many large integrated handling systems is a tremendous improvement in plant communications.

For example, instead of a worker asking his foreman, who in turn goes to a dispatcher, who relays the message to a receiving department foreman, who then goes to a trucker, who in turn may or may not finally respond to the worker's original request, that same worker at Rohr Corp., Chula Vista, Calif., merely calls up the computer to have parts sent to him directly. Not only do all the parts arrive shortly along with all necessary tooling, but his request is verified to him from a programmed voice track in the computer.

In an East Coast engine plant, foremen discovered that with a recently installed integrated handling system, they know precisely what went through their departments, when it went through, and how much value was in the product at the time. At a Midwestern manufacturer of recreational equipment, a five-day year-end inventory shutdown was virtually eliminated since the computer could immediately spew out all information requested by the auditors.

This communication benefit is emphasized by Merle Clewett, general manager of Acco's Integrated Handling Systems Division: "One of the major changes in storage and retrieval systems used for in-process storage for manufacturing is the requirement that the minicomputer controlling the storage system communicate 'on-line' with the user's central computer. Such systems not only provide inventory information, but also allow better monitoring and control of production."

Other products in the materials handling field related to data acquisition also increase the efficiency of plant communications. Harvey White, president of Identicon Corp., states: "There has been a tremendous advancement in the printing of bar coded labels. With specific codes or computer-generated codes, it becomes relatively easy to acquire extremely accurate information and to have this information available at literally a moment's notice." (Editor's note: Perhaps you have noticed the series of bars printed on food cans or drug items. These lines can be



**Automated storage/retrieval systems (such as this Triax system) allow maximum utilization of space in the processing area**

**By using "unit loads" and "captive pallets" almost any type of material can be stored in a storage/retrieval system. This Hartman Engineering system also allows complete product safety as well as an almost perfect inventory control**

automatically read and translated.)

"Source printing of bar codes at the manufacturing level is increasing to the point that within four or five years a high percentage of major manufacturers will be using this system to control flow."

Many plant managers are so impressed with the communications aspect of handling systems that this feature alone sells them on installations. The systems concept has such tremendous economic advantages over previous unregimented materials handling installations that indications are that, by 1980, annual sales of automated handling systems will be a quarter of a billion dollars. Leaders in integrated handling system usage will be the automotive, electrical, and home appliance industries.

## MAKING "TURNKEY" WORK

The first discovery that a manufacturer with his first turnkey materials handling system makes is that it is not a matter of just "turning a key." There are many problems involved with large systems and unless one's own personnel is intimately involved, the problems become even larger.

The manufacturing manager of a large auto parts manufacturing plant stresses this point time and time again. His experiences are typical of plant personnel who have inherited a large integrated system that just can't get on-stream.

"You have to get involved," he declares. "There were five parties involved in our installation, even though we were to have a turnkey system.

"First of all, the prime contractor had three major subcontractors: a division of his company that did the system's software; the control supplier; and a supplier of the conveyors that fed the storage/retrieval system. In turn, the conveyor supplier subcontracted the electrical work to our electrical department, so we were sub-contracting on a system that was supposed to be turnkey to us.

"My first decision was to appoint a strong project manager —one man who could stay on top of all the problems. Secondly, I established a completion date that was two months away and told everyone involved we would turn that thing on or else. The day we were supposed to turn it on, we turned it on. Sometimes we had 17 electricians working on it."

**His Five Recommendations.** "As a result of our involvement in a large integrated handling system, I would recommend close control in the five following areas:

"*Communications with the vendor*–We had a breakdown in communications. A major problem was scheduling and the fact that the prime contractor was not used to working with an automotive company. Being a hard-nosed manufacturing engineer, I wanted our specs to be met.

"I stormed into their place one day and wanted to see prints of our system. They at first said no, but I told them that I *will* see prints and the system *will* be to our specs! We got our prints, and changes were made to follow our specs.

"*Suppliers*–Our specs were necessary so many of the parts for the system could be standardized with other equipment in our plant. Maybe a person pays extra for this requirement, but with it much of the new equipment will match existing equipment that our workers are used to operating.

"Furthermore, since many of our suppliers also furnish items used in production when we say we want something, we get it now. This factor alone saved considerable time in getting electric motors for the conveyor segment of the system.

"*Training*–We had to know what was going on. We can't afford having the system be down while waiting for their service personnel. As I said before, our first step was to have a complete set of prints and manuals on the system. If we had to call the vendor up in the middle of the night, we would be able to refer to specific drawing numbers or instruction sheets. We dedicated certain maintenance personnel to the system, and now they know more about our system than the vendor does.

"*Installation*–Our system was painted a different color than is normally supplied by the vendor. I wasn't responsible for this move, but it sure helped whenever we wanted to check the progress of our system in the vendor's plant. Our personnel could easily spot the progress merely by looking for parts painted our color.

"*Expansion plans*–This is one of those 'good news and bad news' stories. For the 'good news,' we planned two extra storage aisles for future use. It cost a little more in the beginning, but it was worth it. All controls were programmed for the extra aisles and when the aisles were added, it was accomplished during a two-week plant shutdown. The racks were installed a month ahead of the shutdown, but tying the old to the new was easily completed in the shutdown period.

"As to the 'bad news,' we bottled ourselves in. Our system is located in the middle of the plant and now there is no place to go."

**More Than Storage.** "A major additional problem with storage/retrieval systems is that they are often thought of as only warehousing items. We are smarter today. I can see them used for total in-plant processing and eliminating lift trucks altogether. Such systems are definitely here to stay."

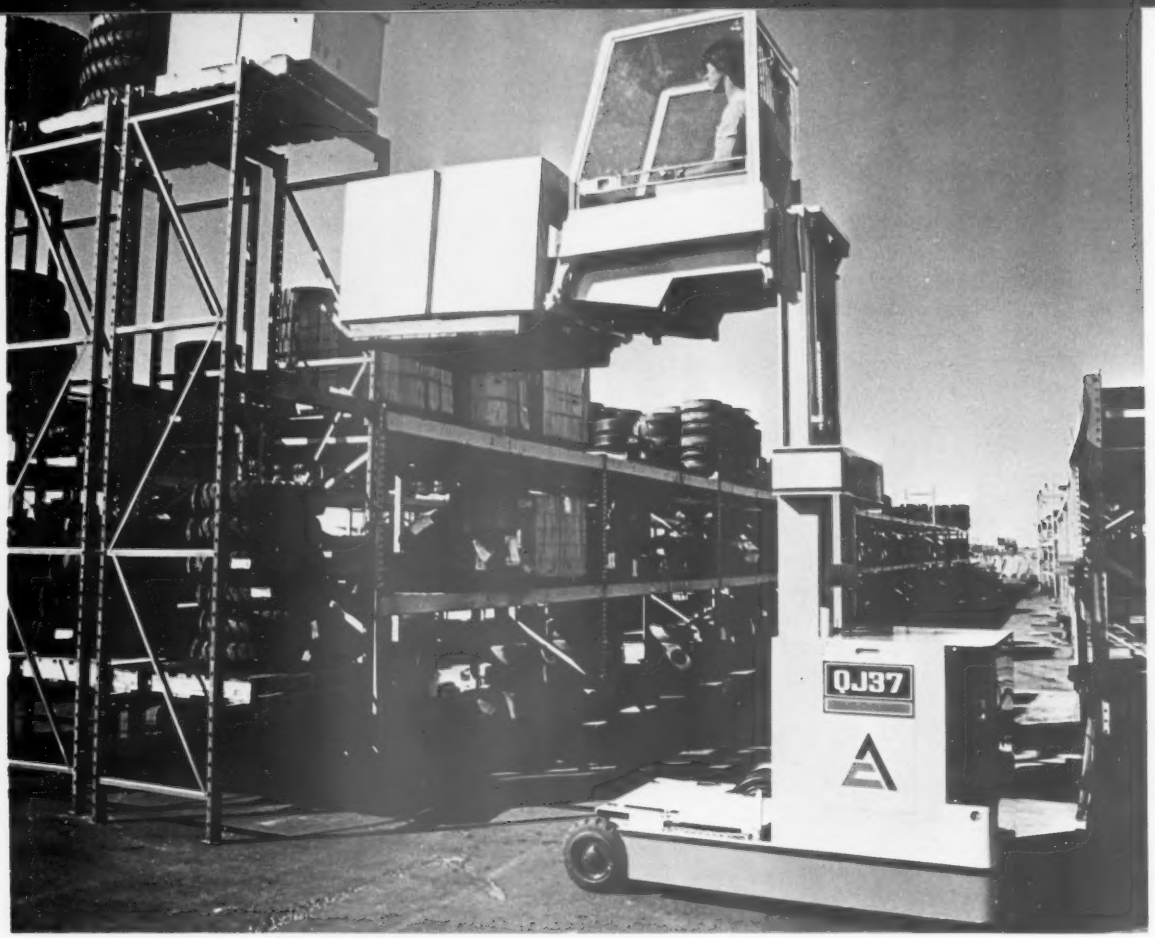
## LIFT TRUCKS MAKE A COMEBACK

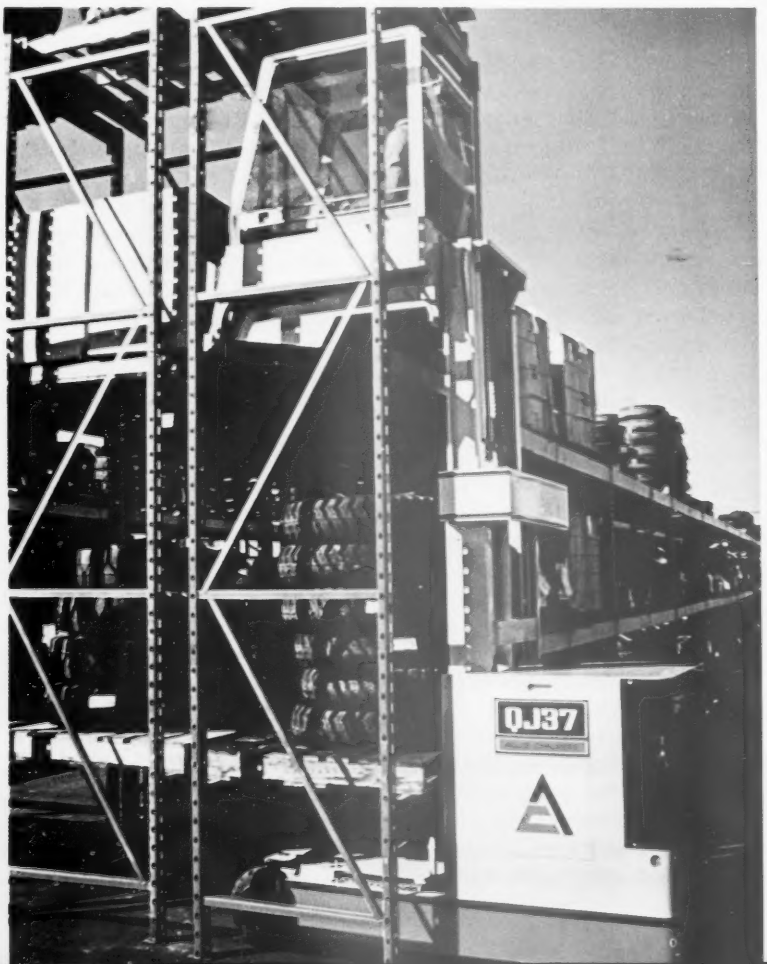
An indicator that there are still exciting developments ahead in the lift truck field is an experimental unit recently shown by Allis-Chalmers. Calling it the "lift truck of tomorrow built with today's technology," A-C has named it the "Quantum Jump (QJ 37)."

Developed to provide a common ground for discussion of users' needs in the years to come, the lift truck is most visibly different from today's unit in having the driver sit in an enclosed cab between the mast and forks. The driver thus has exceptional visibility, and the cab can remain at ground level or travel along with the forks.

The electric truck has computer compatibility and features a regeneration system that recovers about a fourth of the potential energy of elevated loads. On descent, the weight of the load drives a hydraulic motor connected to a generator to recharge the truck's battery.

**Other Truck, Tractor Trends.** According to Thomas Finlayson, manager of systems planning, Allis-Chalmers Industrial Truck Division, electricity will be power-




**Called a "Quantum Jump" by Allis-Chalmers, this new lift truck allows the operator to right into the rack along with the load**

ing a much higher percentage of vehicles. Speed, visibility and lift height to improve productivity will be increased while vehicle size is decreasing. Since all operations will be controlled electronically, he says it will be simple to tie this type of truck to a computer-controlled storage/retrieval system or to automatic traffic controls.

What it all amounts to is "fork truck compatibility." MH equipment suppliers are stressing the "tie-in" capability of the truck to most handling systems. The storage/retrieval tie-in is just one of many where lift trucks will be an integrated part of the entire system.

One advantage the lift truck suppliers have over other suppliers of handling items is financing. Trucks can be purchased, leased or rented and most suppliers allow a free trial period to see if the truck works well in the particular operation.

**Automation hits the truck industry as this Clark guided tractor makes it way around a manufacturing plant. The unit can be programmed to stop at any work station and will automatically stop if any person would get in its path**

Most battery manufacturers also have leasing programs allowing electric trucks to be competitive with gas-powered trucks.

Bruce Goodman of the Industrial Battery Division of Gould points out that many manufacturing managers overlook the economics behind leasing. "You wouldn't buy a five-year supply of gasoline or propane when you buy a gas truck would you? So why do it with electric power?" he asks. He also points out that because of the time value of money, tax breaks and other factors, a lease or rental program often competes very favorably with outright purchase.

Frank Tully, assistant general manager, Clark Equipment Co.'s Handling Systems Division, states: "Don't overlook automatic guided tractor systems. Manufacturing facilities utilizing three or more lift trucks to carry loads over 1000 ft may be wasting considerable manpower and money by doing so."

In some cases, Tully stresses, a driverless tractor system can pay for itself in less than a year. Costs for driverless tractors can range from $9000 to $16,000, depending upon degree of programming sophistication, optional features, and auxiliary equipment. Guidepath costs depend upon the length and complexity of the system and local labor rates and can cost anywhere from $5 to $13 per foot. However, they offer automatic service in the industrial plant without extensive building changes. They can be programmed to start, stop, select stations, operate warning devices, open and close doors, and in multi-level operations even run elevators.

## OTHER FACTORS IN A SYSTEM

Materials handling is a function that ties all machining and assembly operations together. No longer can a piece of equipment just be replaced. The operation should be analyzed to minimize material movement and maximize part availability to the worker.

As an example, a manufacturer of heating and ventilating equipment re-evaluated its assembly operation and decided to isolate it from the machining area. Two important factors were behind the change. First of all was eliminating the contamination carryover from machining operations, and secondly was being able to have the right part for the right assembler at the right time.

Instead of having lift trucks transport pallets of parts with the inherent noise and confusion of trucks maneuvering about the area in search of parts, this company's solution was to incorporate a semi-automatic mini-storage/retrieval system alongside the assembly line. The area is sealed off from the rest of the plant. All parts enter the area via a conveyor, which in turn supplies the storage/retrieval unit.

The operator of the handling system programs the storage machine to deliver incoming parts to an appropriate spot in a rack structure. From the bottom of each rack section is a gravity conveyor that feeds the assembly line. This allows each part number to be delivered to its proper assembly station. Products from the line are transferred via another conveyor to an adjacent room for final testing and painting.

This line is so successful that a similar system for another product line is in the works. Assembly workers appreciate the clean and quiet environment, and productivity has been increased. Chip carryover from the truck's tires was eliminated, too. It should be noted that lift trucks were not eliminated from the plant, just from the area where the appropriate handling equipment could do a better job. ■

*(continued)*

# USEFUL LITERATURE

An 8-page brochure describing **maintenance and repair products** for preventing or

reducing **conveyor belt downtime** is available from **General Splice Corp.**
*Indicate No. 615 on card*

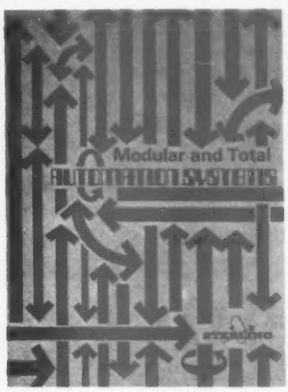
A 6-page brochure describing an **automatic storage and handling system** designed from basic pre-matched components to speed erection and startup is offered by **Triax Co.**
*Indicate No. 616 on card*

A technical manual on the **Trans-Au-Matic automatic work handling systems** designed for use with its

Type L and M **vertical chucking machines** is available from **Bullard Co.** *Indicate No. 617 on card.* Also available is a 16-page brochure containing **general information** on **the automatic loading and unloading systems** for the Mult-Au-Matic and the Templa-Turn. *Indicate No. 618 on card*

An 8-page manual containing **25 safety tips for safe hoist operation** and describing proper and improper ways to lift different loads is offered by **Dresser Industries, Inc.**
*Indicate No. 619 on card*

**Modular and total automation systems for die casting,**




plastics, and forging operations are described in a folder of data sheets, each showing a different application. **(Sterling-Detroit Co.)**
*Indicate No. 620 on card*

The **utilization of hysteresis to control the speed** of standard wood pallets is described in a 4-page technical report offered by **Kornylak Corp.**
*Indicate No. 621 on card*

**General and detailed information**, and the techniques of system design, are presented in a 16-page

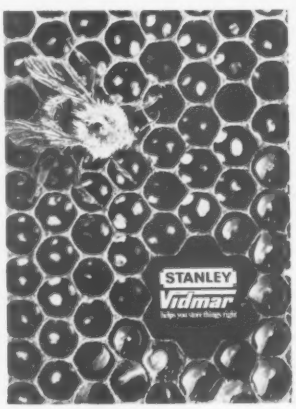
brochure on **push-bar type metal chip conveyors** and systems. **(Kalamazoo Conveyor Co.)**
*Indicate No. 622 on card*

A 144-page catalog listing its **roller chain and sprockets for drive and conveyor sys-**

**tems**, with technical data, specifications, and accessories, is offered by **Link-Belt Chain Division. (FMC Corp.)**
*Indicate No. 623 on card*

A 2-page bulletin explaining the features of its **heavy-duty hinged steel belt conveyor** is offered by **McLaughlin, Ward, & Co.**
*Indicate No. 625 on card*

A 44-page brochure illustrating and describing the company's **modular drawer storage concept and equip-**




**ment** is offered by **Stanley-Vidmar.** *Indicate No. 626 on card.* Also offered is a 12-page brochure describing **a one-man die storage system** that saves manpower, setup time, and money. *Indicate No. 627 on card*

**High-speed live roller conveyors** are described in a 4-page brochure offered by **E.W. Buschman Co.**
*Indicate No. 628 on card*

**Power and free conveyor systems**, their components and

switching elements, are described in a 12-page brochure by **Acco.** *Indicate No. 629 on card.* For a 12-page brochure on **overhead Monoveyor systems**, *indicate No. 630 on card.*

**Steel shelving, industrial furniture, and storage systems** are presented in a 130-page catalog brochure by

**Hallowell.** *Indicate No. 631 on card.* For a 4-page brochure describing how Hallowell **storage walls for small parts** convert dead space into working storage space, *indicate No. 632 on card.*

A 16-page brochure-type catalog describing its line of **industrial lift trucks**, controls, hydraulic attachments,

and special purpose options is offered by **Hyster Co.**
*Indicate No. 624 on card*

**A programmed storage and handling system** to automate handling and storage of mill

length materials and to provide programmed delivery is described in a 12-page brochure by **Kasto.**
*Indicate No. 633 on card*

A 4-page brochure describing its line of **reinforced wood containers** for product protection in handling, storage,

DURA PRODUCTS DURA-TAINER
the reinforced wood container for superior product protection in handling, storage and transit.

and transit is offered by **Dura Products.**
*Indicate No. 634 on card*

A 6-page foldout brochure describing Access **automatic storage and handling systems** is offered by **Hartman**

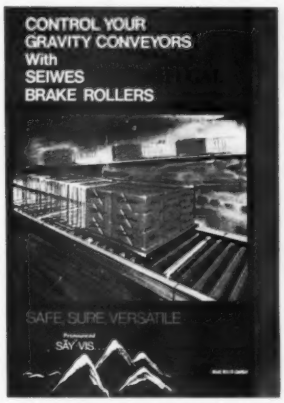
**Engineering.** *Indicate No. 635 on card.* For the 18-page brochure "Access Automated **Storage and Retrieval Systems,**" *indicate No. 636 on card.*

**Selection and use of overhead conveyors** and special material handling equipment are described in an 18-page bulletin by **Conveyor Systems, Inc.** *Indicate No. 637 on card.* For a 4-page brochure on **package conveyors for light manufacturing** assembly operations *indicate No. 638 on card.*

**Seventy applications of dynamometers at work** are

cited in an 8-page brochure by **W.C. Dillon & Co.**
*Indicate No. 639 on card*

**Centrifugal brake rollers** for the control of gravity con-




veyors are described in a 4-page brochure by **Brake Roller Co.**
*Indicate No. 640 on card*

**Wire mesh containers** for handling, storing, and shipping materials and incorporating the Palletainer design are described in a 6-page brochure by **Union Steel Products.**
*Indicate No. 641 on card*

**Air-driven hoists,** their selection and use, is covered in an eight-page booklet from Atlas Copco.
*Indicate No. 815 on card*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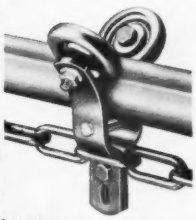

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# Do's and Don'ts for HEAT TREATERS

The complexity of modern production heat treating is awesome. There is no single universal process; no single universal unit of equipment that can handle all jobs. Indeed, the heat treater has more options and variations to consider than an all-pro quarterback.

Unlike the football player, however, the heat treater doesn't get many chances to find out what will work. When he selects a process and equipment to perform that process, the parts produced had better meet both quality and quantity specifications economically or he may become a candidate for early retirement.

In the interest of establishing some helpful "Do's and Don'ts" for harried heat treating engineers, managers, supervisors and metallurgists, the PLANBOOK queried 10 major manufacturers of heat treating equipment. Their advice and comments follow.

• **Heat treating processes are many and varied.** They include hardening, drawing or tempering, annealing, normalizing, carburizing, nitriding, strain relieving, sintering, brazing, etc. Depending on the analysis of the metal to be treated and the result wanted, heating and cooling cycles based on "Time, Temperature and Transformation" curves are established. To achieve certain desired characteristics in treated products, heating and cooling may have to be done in inert or active atmospheres, or in vacuum. Cooling or quenching may involve the use of air, oil, salt, lead or water.

Obviously, the choice of proper equipment is the key to success in applying any of these processes with their attendant variations. And our panel of equipment experts direct much of their attention to selection of proper and adequate equipment.

• **Don't expect more from the unit selected than it was designed for.** R. J. Bemis, general sales manager of Induction Process Equipment Corp., represents a company that manufactures induction hardening equipment ranging from simple scanning machines to highly automated and numerically controlled selective hardening equipment.

He says: "A most common mistake is attempting to purchase equipment that will have the ultimate in flexibility to handle 100 percent of all contingencies. Often, a substantial price reduction could be realized by selecting alternative equipment for that 5 percent of production that cannot be processed economically."

A spokesman for Lindberg, division of Sola Basic Industries, says almost the same thing about purchasers of its furnace equipment. "A customer attempts to accomplish too many diversified processes in a single unit furnace. In other words, he is looking for the universal heat treating furnace. In attempting to achieve this, a standard furnace is modified, raising the cost but still not being able to achieve the desired goal."

Selas Corp. of America, which calls itself "the heat technology company," thinks process needs are too often misunderstood, and recommends that customers not assume that equipment that worked well for someone else will work well for them. "A thorough, objective review of particular production demands is essential," says Selas.

George J. Heisler, manager of sales, Sunbeam Equipment Corp., agrees that the customer benefits when he provides the furnace manufacturer with more specific information on his needs. "In addition to specifying the particular process for which the equipment will be used," says Heisler, "the means of handling (batch, semi-continuous, or continuous processing) should also be included. If a soak time is specified as part of the process, the purpose of the soak should be explained. If the intent is merely to obtain uniform temperature throughout the part, specify the uniformity requirement instead of the time and allow the furnace builder to determine how much time his equipment will need to meet this requirement."

• **Don't underestimate the capacity needed.** Lindberg says a common mistake in specifying furnace equipment is failing to make an accurate analysis of anticipated production requirements. "Although a piece of equipment is quoted for a given heating and quenching rate, common sense is required in creating practical loading densities for various part configurations actually being processed to achieve the best metallurgical properties. Too many times

this single aspect is ignored, using the theory that if you can load the weight into the confines of the work space, you can heat it and quench it," this producer contends.

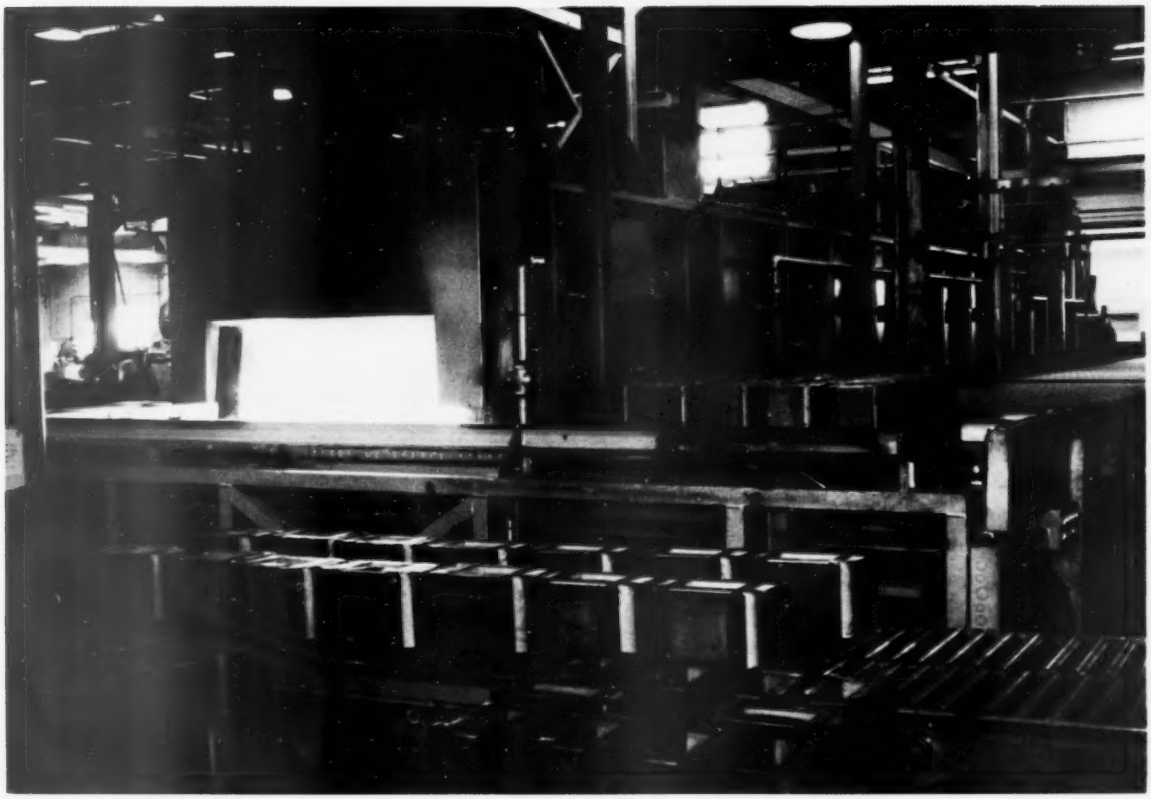
Selas echoes this saying: "A common mistake is buying for present production needs instead of anticipating needs for expanded facilities." Selas also remarks that it's wrong to "base metal heat treating needs on the old, inefficient rule of one hour of heat treating per thumb measure of thickness instead of relying on carefully plotted isothermal curves to point the way."

IPE's Bemis points out that one of the reasons for this mistake is that "the specifying and ordering department is not always the actual equipment user. Quotation negotiations and purchase order specifications are not always adequately interfaced with end-use departments, resulting in omission of components or functions that would substantially reduce setup times and contribute to overall increased productivity."

Sunbeam's Heisler adds: "Production rate should be specified in pounds of product to be produced per hour. And, when multiple parts are to be processed as in the heating and quenching of fasteners, a bulk loading factor should be specified so the equipment meets the specific requirement rather than a general furnace capability. Also, where specific parts are to be run such as shafts, gears, etc., their size, weight, and method of carrying should be specified so that the total load, including trays or fixtures, will be used in calculating the total furnace capacity."

• **Don't ignore maintenance needs.** According to these equipment experts, lack of proper maintenance is a common failing among heat treaters. "It is too often assumed that heat treating equipment is no worse for wear," says Selas. Lindberg remarks on the "eternal reluctance to perform scheduled routine maintenance" and adds: "Too many times furnace equipment is operated until it virtually destructs itself before maintenance is performed." And, Induction Process Equipment Corp. remarks that "spare parts purchases typically fall into an accounting category that necessitates their purchase by departments that do not do the original specifying of equipment. As these costs are from other department budgets, they do not get adequate consideration for purchase until critical situations develop."

IPE's Bemis also says that plant maintenance departments often are not represented during review of design, during equipment qualification runs, and during installa-



**Total load, including baskets, trays or fixtures, should be determined when calculating required furnace capacity**

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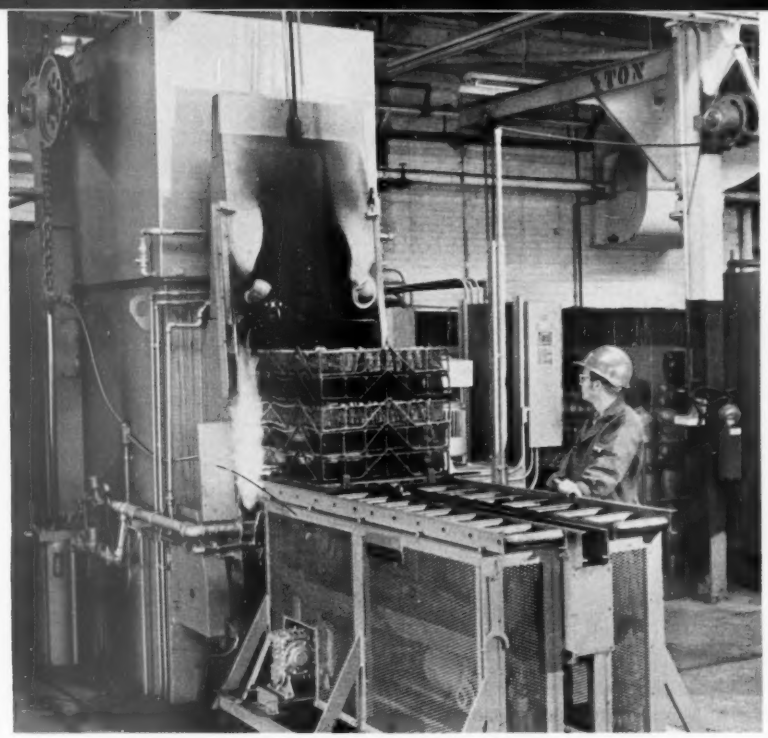


**Sunbeam roller hearth furnace selected for production annealing of transformer cores**

tion start-up when IPE service engineers are at the plant.

Ed Bristol, Sunbeam's manager-field services, in commenting on the maintenance problem says: "The maintenance mechanic should be intimately familiar with all phases of your furnace's operation. With the complexity of today's technology, it becomes increasingly difficult to determine whether a particular problem is due to a combustion, electrical or mechanical cause.

"Many smaller plants have a limited maintenance force with most of the group being jack-of-all-trades capable of handling all phases of maintenance. In larger plants, maintenance groups often are broken into what we call multi-crafts of millwrights, pipe fitters, electricians, and instrumentation groups. In these larger plants we find a tendency to give them all a crack at it, and everyone becomes vaguely familiar with the equipment, but no one really knows it.

"I think you can see what kind of 'maintenance' this leads to," he warns.

He agrees with IPE concerning the need for spare parts: "In the manuals supplied by Sunbeam Equipment Corp., there are spare parts lists. It is highly recommended that the parts on these lists be carried in stock. Some of these items, whether manufactured by Sunbeam or supplied by others, have extremely long delivery times. If one of these items should fail, the equipment is out of production until it can either be repaired or replaced. I think the question users should ask themselves is: 'How long can we afford to have this furnace out of production?' "

Both Lindberg and Sunbeam suggest that operational logs can be great diagnostic tools for determining equipment malfunctions or process deviations. Bristol recommends that dewpoints of atmosphere gas, gas temperature into and out of generators or furnace equipment, air and gas flows as registered on flow meters, and atmosphere flows to a furnace be recorded at the beginning of every shift.

"These data," says Bristol, "give you an indication at the earliest moment of any problem that might be in the process of developing. Should you notice, for instance, that with the same air and gas flows to a generator the dewpoint begins to rise, it is an indication of carbon build-up within the generator or deterioration of the catalyst bed."

• **Don't waste energy.** The present situation concerning energy is particularly worrisome to heat treaters. Most heat treating equipment utilizes natural gas, oil, propane or electric power as sources of heat. And the availability of these has become more important than economic considerations. Particularly is this so in selecting new equipment.

Sunbeam's Heisler warns that "complete data on your utilities should be provided to the equipment manufacturer. This includes electric power supply specifications, complete data on gas or oil supplied (including type of gas, Btu content, specific gravity and

**TEN MISTAKES HEAT TREATING EQUIPMENT BUYERS MAKE**

Engineering Manager N. R. Balzer of TOCCO Division, Park-Ohio Industries, Inc., says these are the most frequent mistakes made by TOCCO Induction Heating Equipment customers. Interestingly enough, all the other equipment makers surveyed also list most of these errors.

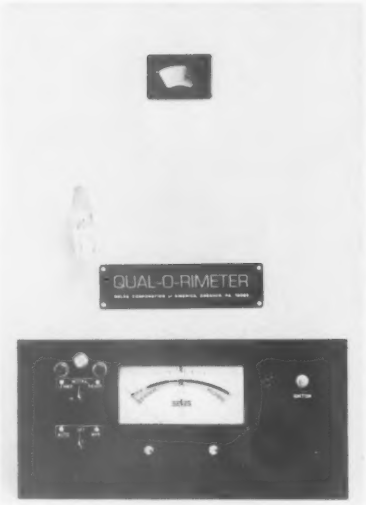
1. Lack of adequate process study.
2. Resistance to change —out-dated specifications.
3. Inadequate utilities, i.e., power, water, floor space, etc.
4. Not providing qualified maintenance personnel.
5. Specifying the wrong frequency.
6. Not allowing sufficient lead time for equipment delivery.
7. Buying solely on price.
8. Establishing heat treat specifications not consistent with the application or requirements.
9. Requesting unnecessary versatility.
10. Not obtaining equipment approval by the department that will ultimately operate the equipment.

pressure at the point of use), and water supply data (including maximum and minimum temperatures for the year, degree of hardness and whether it contains any solids or other impurities).

Project Engineer Ed Siemon at Sunbeam in discussing the problem of fuel shortages says: "Many furnace users are in a quandary about what type of heat source to use. If they order a furnace now they are fearful that a year from now they will realize they chose the wrong heat source. And the situation could change again in three or five years so that the right choice for today could be a very poor one then."

He suggests a solution to this problem is to have a furnace built with combination fuel sources —gas-fired radiant tubes and electric elements, or dual fuel systems capable of burning either gas or light oil interchangeably.

Selas makes two points concerning fuel conservation: Concerning operating discipline, the company says "keeping heater doors open and not maintaining heat-exposed parts such as refractories, insulation, etc., results in needlessly wasteful fuel consumption."




**Instrument monitors temperature of continuously burning sample of gas mixture**

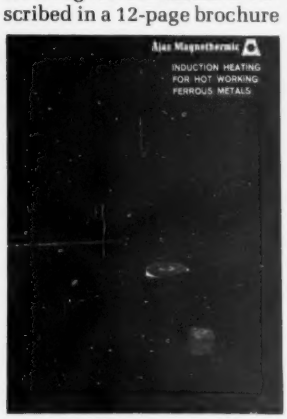
Its second point is that users should not underestimate "the importance of accurate combustion monitoring devices and equipment in helping to conserve available fuel supplies and to cut costs. Some manufacturers still meter 'by eye'—often with disastrous results."

The company markets a combustion control device called a "Qual-O-Rimeter" that monitors the temperature of a continuously burning sample of the fuel mixture so that compensation can be made for variations in humidity, gas chemistry and Btu content in addition to air/gas ratios as indicated by flow meter.

On the subject of process controls, Lindberg remarks that many users believe "greater degrees of automation of process controls eliminate personnel. This is true when considering the man on the floor—the operator. But as the degree of automation increases along with the sophistication of control required, the technological capabilities of the organization must be upgraded to better understand, control, schedule and maintain the equipment."

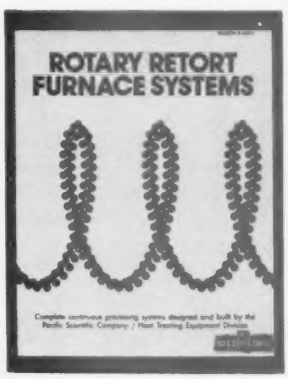
# USEFUL LITERATURE

**Induction heating for hot working ferrous metals** is described in a 12-page brochure




by **Ajax Magnethermic Corp.** *Indicate No. 642 on card.* For a 28-page brochure **"Induction Heating In Action"** *indicate No. 643 on card.*

**Rotary retort furnace systems** for continuous hardening, carbo-nitriding, and



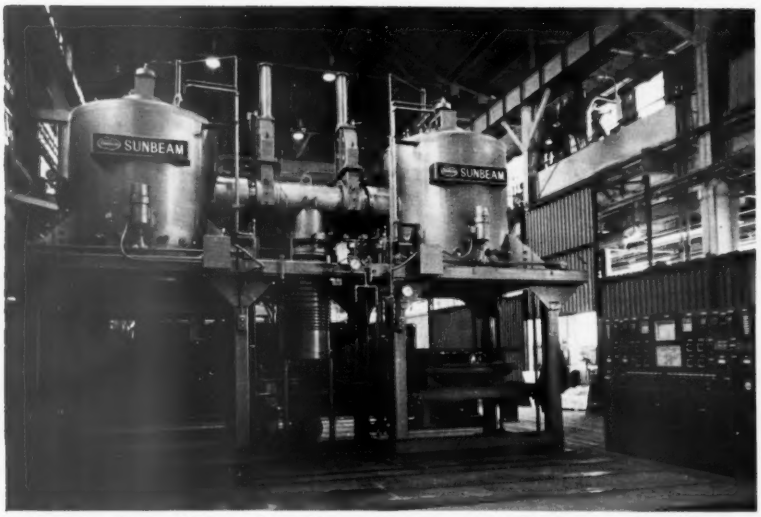

medium case carburizing are described in a 4-page brochure. **(Pacific Scientific Co.)** *Indicate No. 649 on card*

Five heat treating publications are available from **Sunbeam Equipment Corp.**: For a 6-page bulletin on **shuffle-type furnaces** for controlled

atmosphere heat treating and quenching of small parts, continuously, *indicate No. 644 on card.* For a 6-page bulletin on **belt conveyor-type draw furnaces** *indicate No. 645 on card.* For a 6-page bulletin on **mesh-belt controlled atmosphere furnaces** for copper brazing *indicate No. 646 on card.* For a 6-page bulletin on **continuous belt conveyor furnace lines** for small- and medium-size parts, *indicate No. 647 on card.* For a 6-page bulletin on **rotary retort furnace** systems *indicate No. 648 on card.*

**Quenching and marquenching oils,** as well as the principles of quenching and mar-

quenching, are discussed in a 14-page brochure by **Exxon Company, U.S.A.** *Indicate No. 650 on card*




**Bottom loading, elevator-hearth vacuum furnace offers several application advantages**

Walter Swartzfager, Sunbeam engineering manager, points out the advantages of standardization: "It may be necessary to specify certain brands of components such as instruments, motor controls, etc., to maintain a level of standardization within the plant."

• **Don't overlook vacuum furnaces.** Most furnace manufacturers make vacuum furnaces as well as controlled atmosphere furnaces and atmosphere generators. Sunbeam's Sidney Dressler, product manager-vacuum furnaces, explains that this type of furnace has its greatest application potential when one or more of the following is true:

1. Work surface protection is of great importance.
2. Internal work passages must be degassed.
3. Batch operation—cold start/cold stop—is desirable.
4. Process temperatures must change frequently or quickly.
5. Process temperatures are very high.

He adds that there are other reasons that may dictate the choice of a vacuum furnace: "If plant location or building structure limits the use of hydrogen, if gas supplies are not consistent enough to guarantee the quality of generated protective atmospheres, or if energy considerations dictate the use of only electricity, begin thinking vacuum."

Finally, both vacuum furnace processing and induction hardening processing share a common energy conserving feature—when the equipment is idle it isn't consuming energy. ■

An 8-page brochure providing **a comparison of solid state power** to older gen-

erator equipment typically used in induction heat treating applications is offered **by Induction Process Equipment Corp.**
*Indicate No. 651 on card*

**Horizontal vacuum furnaces for brazing,** annealing, gas quench hardening, hydrogen cleanup applications, etc.,

are described in a 4-page brochure by **Lindberg.** *Indicate No. 652 on card.* For an 8-page brochure on **integral quench furnaces** for carburizing, carbonitriding, and clean hardening *indicate No. 653 on card.* For complete specifications on **accessory equipment** for Pacemaker furnaces, presented in an 8-page brochure, *indicate No. 654 on card.* For a 4-page brochure describing **an endothermic gas generator** to produce protective atmospheres for metalworking applications *indicate No. 655 on card.* For an 8-page brochure describing Lindberg's Heat Treatment **teaching program** *indicate No. 656 on card*

Catalog sections on **heat treating equipment** including furnace trays, mufflers, furnace boxes, retorts, heating elements, ammonia

dissociators, endothermic gas generators, and gas density analyzers, are offered by **Rolock Inc.**
*Indicate No. 657 on card*

**Quenching systems using sonic atomizers** to rapidly quench all types of solids, li-

quids, and gases are described in a 6-page brochure by **Sonic Development Corp.**
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# CONTROL SYSTEMS— Brains of the Manufacturing Revolution

**More dramatic than the other developments taking place in manufacturing are those involving controls where, although the revolution is just beginning, its outlines already are clear**

Computers, controls, and the electronic age have just about snowed the average production engineer. With the multitude of languages and technology, he should be glad to hear that in computer software, IBM is reportedly working on a totally new "System Q." "Q" is supposedly to smooth the transition from the System 370 to IBM's next step, the "Future System."

But will we ever reach the ultimate in control technology? It appears that there were just as many electronic developments in '74 as there were in '73 . . . and '75 promises even more developments than '74. The net result is that the ultimate—a "System Z"—will always be just around the corner.

Raymond Noorda, president of General Automation, describes what's happening as a revolution: "Just as machines were the muscle of the industrial revolution —bringing about the mechanization of our manufacturing methods, computers will be the brains of the automatic revolution."

**Watch Out Minis and PCs —Here Come the Micros.** The microprocessor and microcomputer will be to the latter part of the '70s what the PC was to the first part. Already the micros are showing up in testing devices and NC controllers. With the advent of the distributed systems concept, minis, micros, and PCs will all be "talking" with one another.

As described by Michael Ford of General Automation, Inc.: "We define a microcomputer as a full-system computer on a board with its processor on a single chip that offers the performance, the systems features and reliability, and the applications support that are normally supplied with a minicomputer. And it offers these high-performance features in the low-cost, small-size, low-power requirement, and efficient packaging capabilities of a single self-contained printed circuit board."

**This single General Automation SOS chip, mounted in a 28-pin package, replaces the entire SPC-12 processor board in the background**

According to Jim Heaton, vice president, Ann Arbor Computer Corp.: "The fifteen years of evolutionary development from the first process computer system in 1959 to the thousands of systems in use today have seen computer reliability evolve from barely acceptable to excellent. Today, computers are more reliable than most other process control components. During this same period, prices of minimum-size computers have dropped from hundreds of thousands of dollars to hundreds of dollars. Yet the three basic problems of computer applications are still with us: economy, flexibility, and reliability.

"Economy is needed in terms of total installed cost. The cost of the electronics itself have fallen drastically, but the cost of software and installation, which are currently labor-intensive, continue to rise rapidly. Flexibility is needed in that many large systems are changed before implementation is complete. Thus, we must have a flexible modular approach to computer automation that allows reallocation of resources during the project or after the project. Finally, we need reliability in three senses: First, the mean time between failure must be acceptably long for the particular application; second, the mean time to repair must be acceptably short for the particular application; and, finally, in most cases, we should have degraded modes of operation in which although some components have failed, the system will continue to run, albeit in a reduced throughput mode."

Pointing out that the greatest problem to industrial computer usage is in programming area, Heaton states: "It is now recognized that the super efficient,

cleverly coded program almost never exists. Manufacturing and other real-time environments are dynamic, with changing application areas.

"We have learned that the maintenance (in the sense of design changes and correcting design errors) of programs can take as much or more time during the life of the program as the original effort to create it.

"A major factor that will be changing the outlook on industrial computer usage is the large-scale-integration (LSI) computer components. Whether one is considering a complete computer on a chip (CPU, read only memory, read/write memory, and I/O), or whether one is considering CPU subsections such as the various microprocessor chips and chip families, the cost of raw CPU and memory for implementing a computer is approaching zero when compared to total installed system cost. Thus CPUs *per se* have become our least expensive resources. They can be applied in quantity to achieve our objectives of economy, flexibility, and reliability."

Endorsement of Heaton's viewpoints is made by Dwight Carlson, president of Process Computer Systems, Inc. Carlson states: "Although computer hardware has been drastically reduced, software definitely isn't going to follow the same curve. As such, we have developed a microcomputer package that includes a micro CPU with a memory module and software for teaching purposes. Pricewise, the unit isn't that much and it provides enough of the basic necessities for a company to become familiarized with computer operations."

**What Micros Can Do.** Just a few of the mushrooming uses for micros are contained in this list compiled by General Automation:

1. As a controller for a four-axis positioning system using stepping motors. This would apply to any positioning system for automated manufacturing, such as coil winders, automatic components sequencing machines, and automatic parts inserters.

2. As a controller for two-axis closed-loop servo systems. This would be similar to the first, except that servo systems are designed for higher performance levels. This would include high-performance printed circuit board drilling machines and other electronics manufacturing equipment.

3. As an intelligent controller for automated test systems, such as exhaust emission analysis unit. As an intelligent controller, the micro would control the analysis and pass/fail recognition for automotive as well as test systems for electrical and electromechanical products.

4. As a front-end communications processor, micros can handle the disciplines and condition and validate data for processing by a larger computer system. This would be useful in factory data systems, particularly from remote locations.

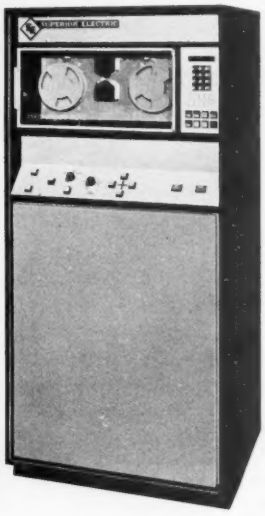
5. As a remote data-entry terminal and as a remote servo or stepping motor controller, the micro can automate such large operations as warehousing. An operator would simply type in the purchase order, and the central computer would prepare all the invoicing and shipping documents. At the same time, micro-controlled stacker cranes and/or conveyor belts would pull the products off shelves and send them to shipping for packing and

**This contoured mold is being produced by a three-dimensional PMC system from General Automation. Produced conventionally, 200 to 300 manhours of direct labor would be required. With the PMC system, only 3 to 4 hours of direct labor plus about 25 hours of automatic machining are required**

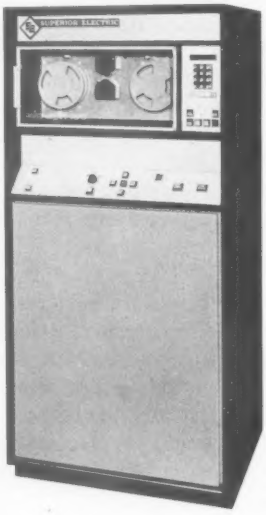
**While hardware comes down, software costs go up. This microcomputer kit enables the production engineer to gain experience through self-instruction**

# Buy smart...buy basic capability

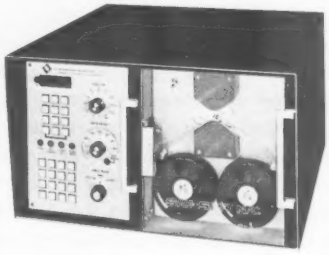
You may get the idea from some control manufacturers that NC stands for "No Choice" as well as Numerical Control. Their price for an NC system may be several thousand dollars above Superior Electric's Slo-Syn® NC due to an expensive list of standard features. It doesn't have to be that way! Superior Electric offers you the necessary control functions without frills, at a low price, then gives you the *flexibility* of a complete option list. Whether for retrofit or OEM, you can start with a basic Slo-Syn PNC or MNC system and add just what you want to have, rather than what you have to buy! For example, these options can be as sophisticated as the new information storage options that have standard memories up to 4000 characters with up to 20,000 possible.



For MILLING, CUTTING, WELDING and other production applications requiring high-speed contouring capabilities, MNC two-axis or three-axis controls have linear and circular interpolation effective over the entire feed range. They are hard-wired for optional computer interface to allow plug-in control from external peripheral equipment. Positioning rates are up to 300 ipm with 5-pitch lead screws.



For POSITIONING, PNC types can be applied to a wide range of automated applications requiring two-axis or three-axis point-to-point controls. Positioning rates are up to 300 ipm with 5-pitch lead screws. Standard features include an automatic tool cycle for operations where work is performed after positioning. Options include independent third axis, full feed range, 4mm lead screw control.



ECONOMICAL two-axis point-to-point and straight-line ENC controls are ideal for retrofitting small milling and drilling machines, assembly and test equipment and for other similar manufacturing operations. Positioning rates up to 200 ipm with 5-pitch lead screws. Standard features include push button keyboard for manual data input, automatic backlash compensation, TTL integrated circuits.

*We can help you stay close to basics and save money.*
*Write for complete Slo-Syn NC literature file from The Superior Electric Company, Bristol, Connecticut 06010.*
*Or call Bob Brechter 203/582-9561.*

**The Superior Electric Company**
We always live up to our name



INDICATE NO. 238 ON BUSINESS REPLY CARD

shipment. The invoice would be shipped with the order.

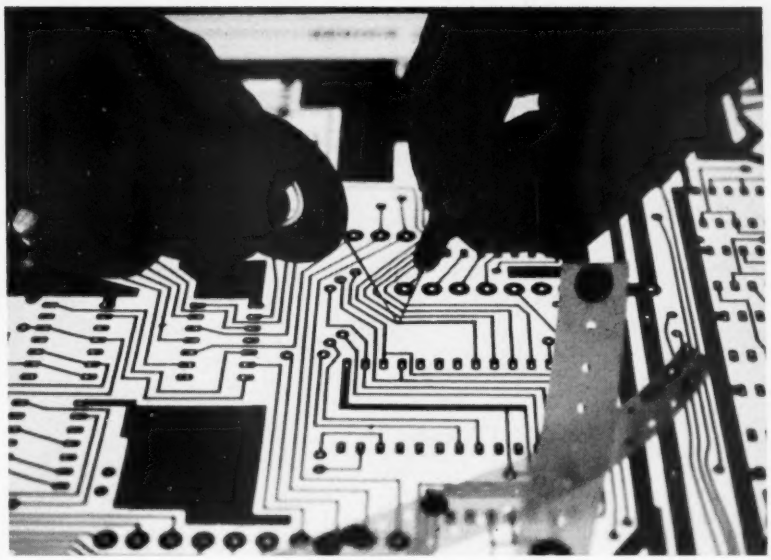
Actually, the micro should not be looked at as a competitor of PCs or minis. It is just another refinement of computer technology, and applications will dictate the ultimate usage. Microcomputers are so cheap they are able to penetrate markets no computer has entered before. Thus it is highly probable that a line of radically new microcomputers will appear in the next few years incorporating architectural concepts alien to anything seen before and aimed at high-volume, low-cost markets that are new to the computer industry.

**Forward with the PC Revolution.** PCs are still the darling of many industrial personnel and will continue to be so for many years. Although the first generation programmable controllers were scaled down minicomputers, second generation PCs still use minicomputer principles but are mainly designed for processing logic control functions. As such, the PC has been designed for the industrial environment and is usable by shop personnel.

Acceptance by shop personnel has, however, been anything but automatic, as these comments by a young industrial engineer indicate.

"At first we had some problems," he relates. "Most of our upper management are old tool people and believe in relays. However, a recent addition to plant management is a works manager who has an EE degree. He is the first person in upper management that has an appreciation for electronic and computers. We have had a lot of fights with the tool people and we have had a tough selling job to get the new controls. The tool people didn't like controllers. They wanted to see an actual relay energizing the energizer.

"But after we got our first four controllers on a large resistance welder job, where the temperature on the controller was 170 F and in a harsh atmosphere, the tool people started to change their minds. We had a few problems with cards, infant mortality problems, but afterwards the controllers ran and ran and ran. From then on, the flood gates opened. Now, in addition to 10 Modicons we have, we have another 40 on order."



**A printed circuit board being designed for an Eagle Signal Controlpac II solid state logic control system**

Now that PCs are in this engineer's appliance manufacturing plant, a whole new control philosophy has been established. Specific standards incorporating PC specifications are written for all new equipment procurements. These say: "In the event a machine tool vendor uses a programmable controller not covered in these specifications, the system specifications *must* be approved by Systems Engineering before the quote is made."

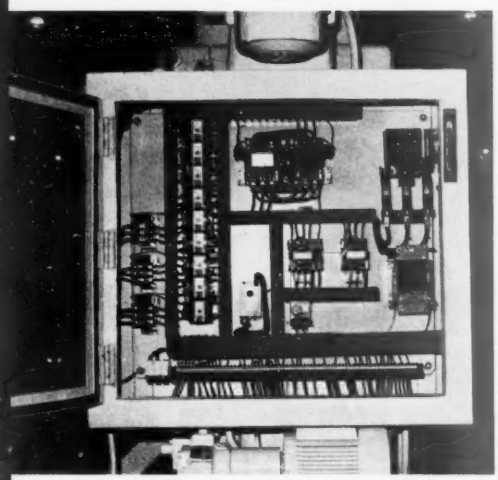
This systems engineering department has its own Modicon controller and a Digital Equipment Corp. PDP-8e minicomputer for experimental purposes. Eventually, all PCs in the shop will be tied into the minicomputer for management reporting and maintenance diagnostics.

As they say, "You've come a long way, baby!"

**Long Live the Relays!** Although computers and PCs are in the limelight, all areas in control technology are experiencing growth. Many relay manufacturers state that relay sales continue to increase every year, with many relay manufacturers also supplying solid state units as well as the electromechanical devices.

William Lawrence, marketing manager for GE's General Purpose Control Products Department, is extremely enthusiastic about the future of the whole control business. He states: "Because of the need for greater productivity, industry will continue to grow, and the needs for control equipment at all levels will continue to grow with it.

"Obviously with the advent of new control technologies, especially in the area of solid state control and the miniaturization of programmable control, greater reliability and sophistication will be more widely available to all control users. In the PC area, smaller and smaller controllers will evolve with the advent of microproces-



**Relays are still in vogue as evidenced by this GE relay panel on the back of a new NATCO drilling machine**

sors and they will find application in small manufacturing processes, where fewer and fewer discrete decisions are to be made. However, these smaller, less expensive and less capable controllers won't displace the larger PCs; larger, more complex applications will still need the large-scale capabilities and expandability of the multi-memory system now available.

"There will also be a continuing and growing need for relays of all types. Future needs will be met with more reliable and flexible full-feature relays, and there will be a growing trend towards solid state control through solid state relays and hard-wired solid state logic devices. Programmable control definitely won't displace relays as some PC enthusiasts have predicted."

**NC at a Crossroads.** As far as NC equipment is concerned Ted Smith, marketing manager, Sperry Vickers UMAC Electronic Industrial Controls, has this to say: "At this point in the development of numerical control, the comparison between softwired and hardwired controls must be made very carefully. There is no cost advantage to the end user in a softwired control. Hardwired controls by the nature of their components are considerably less expensive to manufacture. A hardwired control which has program storage and editing capability at the machine offers all of the operational advantages of softwired controls and none of the cost disadvantages."

**Increasing Yields through Electronic Testing.** One area that is being rapidly systematized is the gaging and testing facets of manufacturing. Minicomputers are extensively used by most testing equipment manufacturers, and, with the development of the microprocessor, even more testing installations will be automated.

The advantages of being able to monitor, test, or gage automatically are obvious. According to Teradyne, Inc., the goal of any manufacturing operation is a simple one: to receive the greatest profit by producing the highest yield per dollar. The best way to do this is to incorporate testing procedures right from the beginning of the production line and not just at the end.

Teradyne, therefore, emphasizes the following points to observe in establishing a testing program:

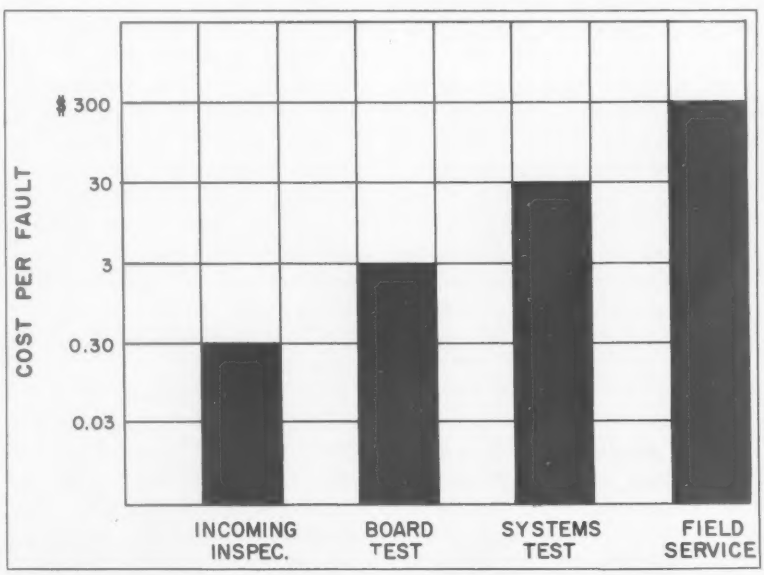
1. Any testing program that places the entire burden of quality on final test alone is missing the point—the defects that drive yield down are of several totally different types, each requiring specialized attention.

2. The earlier in the production process a fault is eliminated, the less expensive it is.

3. Testing each part prior to testing the entire assembly will minimize the overall testing cost and should result in greatly increased product reliability.

4. An example of the potential of automated gaging is illustrated by the second generation electronic and torque control system for threaded fasteners, recently introduced by Ingersoll-Rand. Using a dedicated microcomputer, the system can monitor and control torque as well as acquire, store and process data for up to 40 different fastener spindles, each having its own torque inspection and control levels.

The system provides an immediate "exception" report on any fastener that fails to achieve specified torque levels. The printout specifies machine number, spindle number, date and time, actual torque achieved on the pres-




**This chart illustrates how the cost of finding faults rapidly increases the further into production a product gets**

**Improved torque monitoring and control during assembly operations have greatly reduced fasteners and other parts from loosening in the field. This work station is a TAS II Torque Assurance system by Ingersoll-Rand**

**A small incoming inspection test instrument, such as this Teradyne Analogical Circuit Test for digital ICs, can greatly reduce the amount of testing at later production stages**

ent machine cycle, and high-low torque acceptance levels.

Whenever desired, an operator or quality assurance department member can obtain on-demand reports providing all the information just noted, plus the torque levels achieved in the prior 10 machine cycles. End-of-shift reports specify total number of good parts produced and number of bad parts along with torque values for each spindle.

This system frees plant host computers for other tasks, since the micro is dedicated solely to fastener quality assurance. The unit can be interfaced with a memory storage bank or a larger CPU for transfer of data on a time-sharing basis.

Many of the trends in testing and gaging are summarized in the following comments by Louis Heinhold, vice president/marketing, Federal Products Corp.:

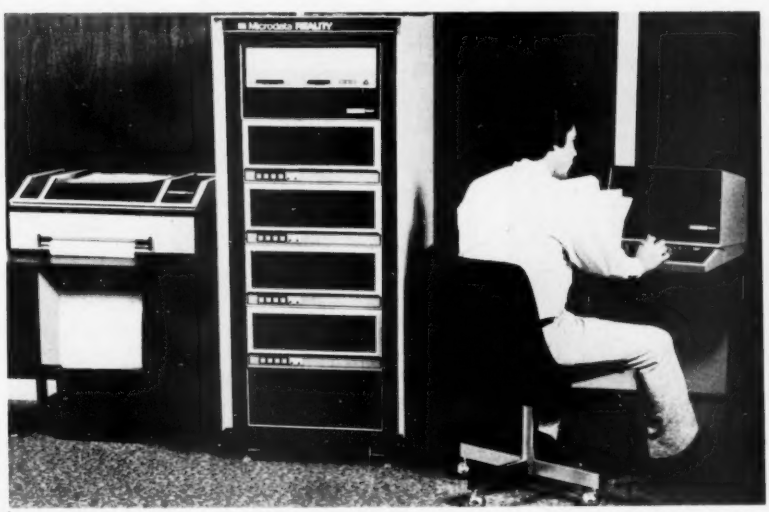
"Automatic Gaging—both in-process and post-process—will continue to be the hottest product line in our industry. The dominant trend appears to be marrying new concepts in automatic gaging with the production machining process. For example, on automated transfer line machines, automatic tool compensation can be applied, controlled by feedback signals from an in-line post-process gage. Another example is a form of adaptive control whereby an automatic in-process gage will direct the metal removal process, adjusting the machine cycle to suit the dimensional condition of the part.

"Another significant trend is the increased utilization of PCs and mini- and microcomputers as integral components of an automatic gaging package. Computer-assisted gaging will find a broad range of applications from the basic data acquisition mode for workpiece qualification and QC analysis to real-time operation for control of gaging and/or machining processes.

"Electronic Gaging—Electronic circuitry miniaturization has come to the fore, resulting in much more compact gaging packages. There is also a greatly increased usage of digital displays, offering several important advantages over analog units. In addition to a higher level of accuracy and much faster response time, a digital amplifier has the built-in capability to interface with other digitally operated components. And because a digital readout accurately displays an exact value, there is no room for misinterpreting the reading. There is no need for an operator to interpolate readings between graduations, thus eliminating one of the greatest sources of measurement error.

"In essence, the same digital concepts that are now being applied in modern machine tool design are also being incorporated into new electronic gages. We can clearly see the emergence of a totally integrating manufacturing and quality control technology where both the workpiece machining and inspection operations are combined into one, with the gaging system not only monitoring but also actively controlling the entire production process."

As to the metrication challenge and its influence on control technology, Heinhold adds: "For our



**This Microdata management information system has a computer language that can be used by anyone who can type in a question and read the reply. They call their language ENGLISH**

part, metrics are nothing new to us; we've been designing and marketing metric model gages for over 40 years. In fact, most of our current catalog models, as well as virtually all of our newer electronic gages, have English/metric capability built in. If and when metric conversion ever comes about, the biggest problem for gage manufacturers and users won't be the substituting of metric graduations for English, it will be the redesigning and replacing of gage tooling and fixturing to meet useful metric sizes and capacities." (For other information on metrication, see p. 00.)

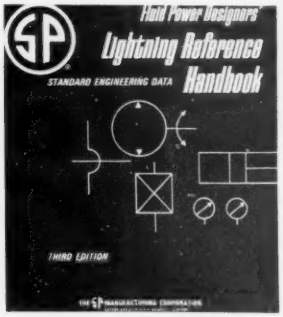
**Where Do We Go From Here?** A fragmented approach to the systems and controls area is not the answer. Solid state electronics, whether in the form of PCs, microcomputers, minicomputers, or total computer control of the plant, is reaching almost every industry in the country. Instead of NC, we hear more and more about DNC. Electromechanical relays are becoming solid state relays. Instead of electronics being only the young generation's technology, home products such as the electronic calculator and the ever increasing use of electronics in industry, have won the acceptance of many older workers.

Rather than thinking of computers in the old military fashion, the hierarchical approach, the new outlook is distributed systems. This concept is explained by Ann Arbor Computers' Heaton: "Technological changes in computerization will be felt primarily in the areas of reducing programming and installation effort. In the next few years these will be manifest in two basic areas: system architecture and system marketing concepts.

"System architectures will come to make greater use of multiple CPU configurations, many of them preprogrammed for specific dedicated tasks. In some cases multiple CPUs will exist within one enclosure each doing a dedicated task (e.g., IBM 370/125). In other cases, multiple CPUs will be physically distributed throughout the manufacturing complex and interconnected by some means of high speed, bit serial communications" (as an example, see PRODUCTION, December 1974, p. 77, "Volvo's Swedish Connection). "Redundancy will be achieved by having two or more computers doing parallel tasks. In a distributed architecture of this type, flexibility can be provided by modular remote processors, with readily interchangeable input, output, and read-only memory sections. Thus as plant layouts, production machinery, and even product mixes change over the years, the various remote processors can be readily reconfigured to accommodate these changing patterns. At the same time, the sharing of standard modules minimizes the number of separate spare

# USEFUL LITERATURE

**A 60-page quick-reference handbook for fluid power** designers lists standards and practices, fluid power data,




pumps and motors, and includes a standard glossary of terms. **(SP Manufacturing Co.)**
*Indicate No. 696 on card*

**A guide to improving heat treating operations** with instrumentation including atmosphere controls, monitors, sensors, and specialized furnace systems is presented in a 10-page brochure. **(Leeds & Northrup)**
*Indicate No. 697 on card*

**Digital data surveillance instrumentation** for scanning, alarming, or logging from 36 to 576 inputs is described in a 16-page brochure. **(Leeds & Northrup)**
*Indicate No. 698 on card*

**A control panel layout kit** containing seven sheets of decals and instructions on

how to use them along with an oiltight manual controls selection guide make the control panel designer's job easier. **(Micro Switch)**
*Indicate No. 699 on card*
Micro Switch also offers: A 12-page **"Photoelectric Controls/Applications Handbook."** *Indicate No. 700 on card.* A 36-page **"Mercury Switch Instruction Manual."** *Indicate No. 701 on card.* And a 12-page pocket-size **"Suggestions for the Proper Application of Industrial Limit Switches."** *Indicate No. 702 on card*

**"The Value of Micropower,"** a 150-page microcomputer handbook, is available from **General Automation, Inc.**
*Indicate No. 703 on card*
Also available are: the 200-plus page **"The Value of Power, and How it Saves You Money on your Minicomputer Systems."** *Indicate No. 704 on card.* Plus a 16-page brochure **"Adapt-A-Path Systems."** *Indicate No. 705 on card.* And a 30-page brochure introducing the world's first **silicon-on-sapphire processor on a single chip.** *Indicate No. 706 on card*

**A 70-page combined catalog and engineering handbook** covering its complete line of solenoid valves is available

parts kept by plant maintenance and additionally reduces training required for maintenance personnel.

"The key to this distributed computer system architecture is the use of LSI microprocessor-based computers of a standard modular design. Many of these will be used on a dedicated application basis and can, for that reason, be supplied as preprogrammed units.

"In general, this will lead to computers being marketed in three distinct classes: general-purpose computers (PRC), fixed-application computers (FAC), and fixed-function computers (FFC).

"GPCs are those monstrosities we all think of when we hear the word computer. With or without an operating system, they are almost completely user programmable and require a variety of programming languages for use by professional programmers.

"FACs are already with us. They are computers packaged for a specific environment and programmed in a language unique to that environment. For example, the Hewlett-Packard 65 programmable calculator, the wide variety of PCs intended to replace relay logic, and the various dedicated process controllers such as the Fisher DC².

"Finally, we will also find in the marketplace FFCs. These, too, are packaged for a particular application, but are supplied to the end user preprogrammed and therefore usable as a fixed function device. The new remote I/O multiplexer by Process Computer Systems, and the controllers now being used on some traffic lights and office copiers all fall into this category.

"Thus, the future involves the almost 'wasteful' use of CPU power in a system of logically physically distributed CPUs. These will communicate with each other via some kind of plant level and/or office data highway. Many, but not all, will be preprogrammed as FACs or FFCs by their respective vendors. In this way, very inexpensive CPU hardware will begin to displace very expensive installation wiring and custom programming.

"The major single obstacle to this concept is the development of a vendor-independent plant level communications technology and protocol. The new ACSI/IBM synchronous data link controls (SDLC) protocol appears well suited to this application. But the selection of a particular communications technology, a standardized interfacing technique for various units from various manufacturers, and the broad acceptance of this as a standard are the primary obstacles at this time.

"Nonetheless, the trend is clear. We are approaching an era of distributed computer systems. And more often than not, the pattern used will not be hierarchical." ■

from **Atkomatic Valve Co. Inc.**
*Indicate No. 707 on card*

**An application summary on NC tape preparation,** editing, and verification is presented in a 4-page brochure. **(Hewlett-Packard Co.)**
*Indicate No. 708 on card*

**Three publications offered by Hamlin** include the 10-page **liquid crystal display application manual,**

*indicate No. 709 on card;* the 22-page **"Reed Switch Application Notes,"** *indicate No. 710 on card;* and a 13-page **collection of application notes** dealing with switching in general, using a controller rather than a relay.
*Indicate No. 711 on card*

**The facts of reduced voltage starting** are presented in a 4-page brochure. **(Square D Co.)**
*Indicate No. 712 on card*

**An automatic electronic product counting/feeding system** with integral supply hopper is described in a 5-page product bulletin including photographs and available from **Automated Packaging Systems, Inc.** *Indicate No. 713 on card.* Also available is a 3-page product bulletin on **a weigh counting system with digital readout.**
*Indicate No. 714 on card*

**A machine building block system** including feeds, slides, swivels, and accessories is described in a 36-page catalog offered by

**Setco Industries, Inc.** *Indicate No. 715 on card.* Also offered is a 6-page catalog on **hydrostatic spindles and slides.** *Indicate No. 716 on card.* And a 64-page catalog described as the "bible" of **machine spindle engineering and application.**
*Indicate No. 717 on card*

**Precision linear motion bearings** and positioning tables are described in an 80-page

catalog by **Bendix Industrial Tools Division.** Design and installation are included.
*Indicate No. 718 on card*

**How it helps solve rising production costs** problems with manufacturing systems and production machines and numerical controls is de-

# USEFUL LITERATURE

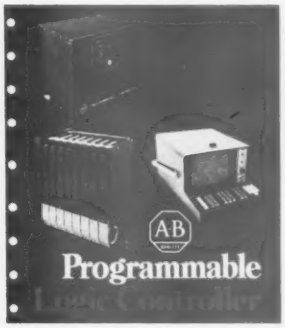
scribed in a 4-page brochure. **(Bendix Corp.)**
*Indicate No. 719 on card*

**Three 6-page fluid control brochures** are available from **Fluid Controls, Inc.** For **"Hydraulic Motion Con-**

**trols,"** *indicate No. 720 on card;* for **"Hydraulic Pressure Controls,"** *indicate No. 721 on card;* for **"Hydraulic Flow Controls,"** *indicate No. 722 on card.*

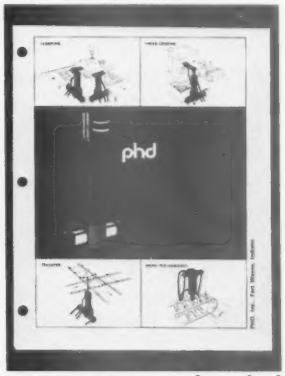
**A 16-page photoelectric design guide** by **Standard Instrument Corp.** provides a semi-technical discussion of photocells and phototransistors as well as a thorough description.
*Indicate No. 723 on card*

**A programmable logic controller** that offers a visual display of the control circuits as they are being developed and two-level fault detection is described in an 8-page brochure by **Allen-Bradley.**




*Indicate No. 724 on card.* Also offered is a 4-page brochure on the company's 7300 line of **computerized numerical controls.** *Indicate No. 725 on card*

**Fluid power devices** that combine the linear motion of a cylinder and the motion of a




rotary actuator are described in a 16-page brochure by **PHD, Inc.** *Indicate No. 736 on card.* For an 8-page brochure describing air and hydraulic **rotary actuators,** *indicate No. 726 on card.*

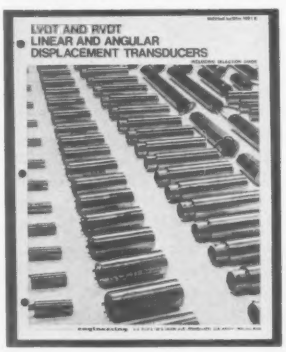
**An engineering design guide** of more than 80-pages for **ball bearing screws and splines** describes standard and custom screws and splines as well as special assemblies and actuators. **(Saginaw Steering Gear Division)**
*Indicate No. 727 on card*

**"Honeywell in Factory Automation,"** a 26-page brochure, describes the company's **Corporate Progam Center** which brings together control and information systems to provide the automation customer the goods

and services required for computer-based automation programs.
*Indicate No. 728 on card*

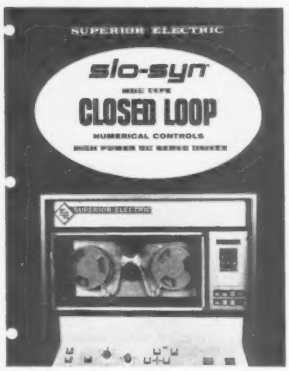
**Four general purpose manuals and one introduction and component description manual** are available **from IBM:** For IBM System/370 **machining and display application program** for IBM 5275 direct numerical control station, *indicate No. 729 on card.* For IBM System/370 **automatically programmed tool,** basic contouring, *indicate No. 730 on card.* For System/370 APT-BP **Numerical Control Processor,** *indicate No. 731 on card.* For System/370 APT-AC **Numerical Control Processor,** general information, *indicate No. 732 on card.* For IBM 5275 **direct numerical control station** introduction and component description, *indicate No. 733 on card.*

**A 24-page technical bulletin** and selection guide for **linear and angular displacement transducers** is available from




**Schaevitz Engineering.** *Indicate No. 734 on card.* For an 8-page brochure describing the company's line of **precision gage heads** and their theory of operation *indicate No. 735 on card.*

Several pieces of literature dealing with numerical controls are offered by **Superior Electric Co.** For a 4-page brochure describing Slo-Syn **closed loop numerical con-**




**trols** and high power dc servo drives, *indicate No. 539 on card.* For a 12-page brochure describing **numerical controls, drive motors and mounting kits,** and auxiliary equipment including positioning tables, *indicate No. 540 on card.* For a 4-page brochure describing **NC drilling machines** and NC drilling/digitizing machines, *indicate No. 541 on card.* For a single data sheet describing **information storage options** for Slo-Syn numerical controls, *indicate No. 542 on card.*

Hard-wired, **two-axis computer control for contour turning** is explained in a report from Sperry Univac. The concept, features, and options of UMAC 7e21C system are explained. *Indicate No. 816 on card.* For similar information on UMAC 6e NC system with **two-axis point-to-point control,** *Indicate No. 817 on card.* For information on the **Editable Stored Program** option to the UMAC 7 control, *Indicate No. 818 on card*

# FINISHING:
## THE LAST OPPORTUNITY... to add customer appeal, display quality, and compete in the marketplace

In one way, industrial finishes compare to the frosting on a cake—both decorate the product and provide customer appeal. But, unlike the frosting, industrial finishes are expected to last for years while subjected to all kinds of abuse.

Painting and plating, of course, are the most widely used and offer wide variations in applications and benefits. At lowest cost, painting is the most commonly used process but presents limitations in the areas of durability and longevity. A refinement of the painting process, powder coating, affords excellent surface finishes, but its cost exceeds that of painting by 200 to 300 percent. Plated surfaces usually are of a superior quality with excellent eye appeal, durability and wear characteristics. The process' additional surface preparation and costly plating materials, however, boosts its expense considerably.

Selection of a product's surface finish must be based on several critical factors, including the product's functional requirements, expected service life, type of material, size, configuration, production volume, material handling, etc., and process cost.

**Painting.** Rising materials costs and government-imposed EPA regulations are slowly narrowing the economic advantages that painting has over other finishing process. Cost-conscious manufacturers are investigating the possibilities of changing materials, upgrading facilities, buying new painting equipment, and/or converting to alternate processes.

To hold their markets, paint manufacturers are engaged in several developments, among which are reducing solvent vapor emissions. Presently, the major thrust is refinement of water-reducible paints. Tremendous gains were achieved during the past year, and accelerated progress is predicted in the near future. Most paint manufacturers offer water-reducible paints containing about 20 percent solvents, and some brands have excellent qualities. High-solid paint is another material development gaining acceptance. High-solid paint is essentially a heavy viscous material containing about 80 percent solids. Unfortunately, it is difficult to apply and requires modifications of existing equipment. A heat exchanger must be added to heat and maintain the paint to a controlled temperature and lower its viscosity for atomization and application.

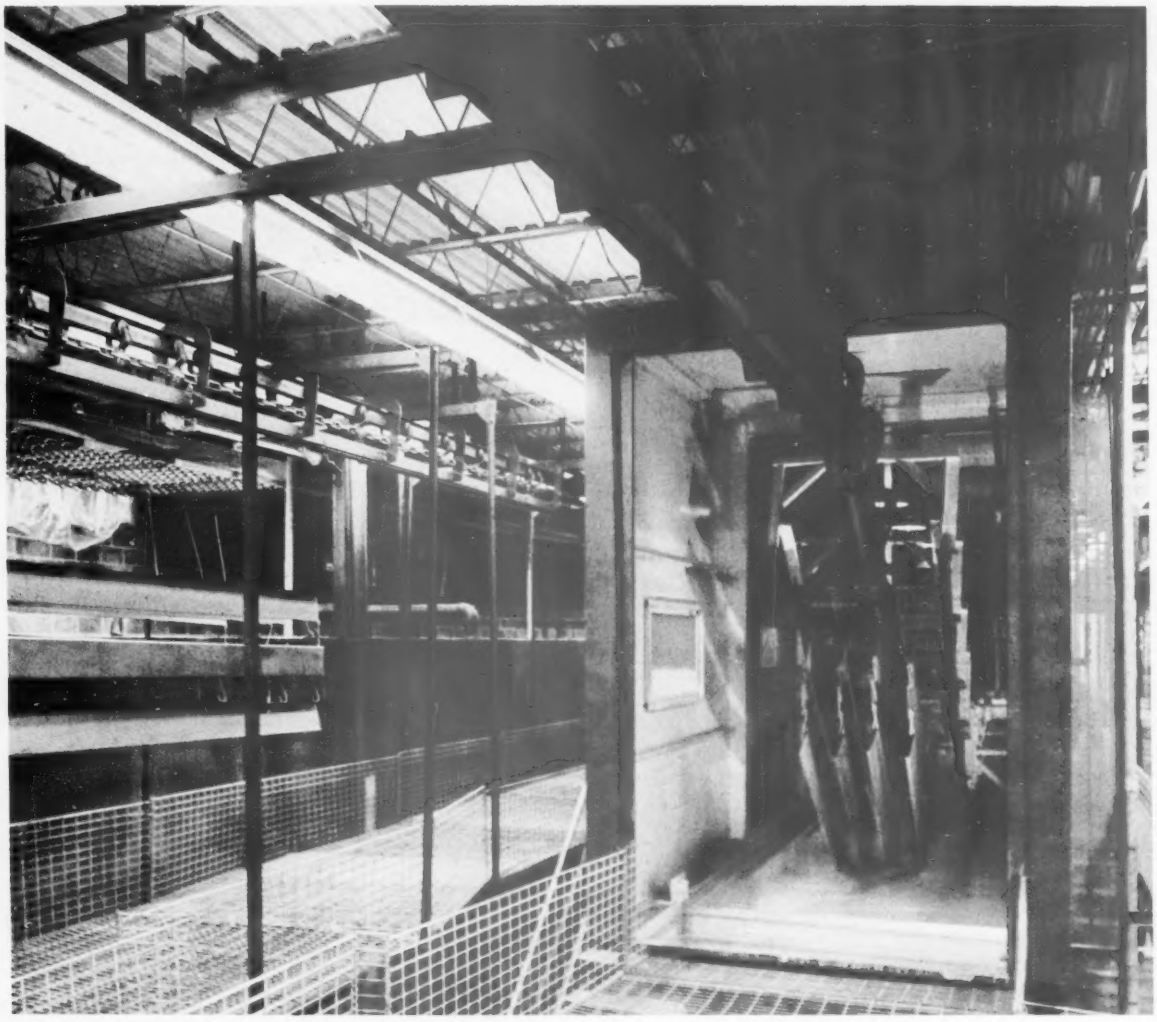
A two-part liquid plastic paint material is the newest, and most expensive, material. Two liquids are fed separately and mixed at the spray gun. Its primary benefits include extremely tough coatings which cure, or chemically react, after application on a surface. The self-cure feature significantly reduces the requirements for baking.

Numerous developments in the painting and powder coating area originate in such customer-assistance facilities as DeVilbiss Co.'s research laboratory in Toledo, O. Specializing in production process and method developments, this lab provides valuable assistance and recommendations to improve or solve manufacturers' coating problems. In some cases, problems may require a year's research to ultimately develop a highly productive painting system capable of high-quality surface finishes, compatible with a customer's product line and its plant facilities.

Recently, the lab worked with a leading sporting goods manufacturer for better finishing of wood tennis rackets. After solving the product's non-conductivity problem with a low-cost conductive prime coat, the lab recommended an electrostatic paint system.

Now, a new low-voltage, short-stroke reciprocator system in the manufacturer's plant is providing a 100 percent productivity improvement. The system coats wood tennis rackets at a 12-fpm conveyor speed applying a high-quality urethane paint without runs, sags, blemishes, or surface imperfections. Additionally, because paint consumption is at an absolute minimum, a cost reduction over the previous air spray method is being obtained.

Another unusual lab challenge involved working with a manufacturer to solve an age-old problem of squeaking bed springs. Latex coating eliminated the problem, but conventional air spray



**A large conveyorized paint dip tank at one of Acco's plants processes an unlimited variety of metal parts**

methods utilized only about 30 percent of the material. By using the wrap-around feature of electrostatic spraying an over-50 percent material utilization is being realized.

Following the research recommendation, the bed spring manufacturer installed a high-voltage long-stroke reciprocator electrostatic painting system in seven plants. Bed springs suspended vertically on a 24-fpm monorail conveyor are coated with a latex paint from one direction; the electrostatic feature provides adequate coverage at all metal joints.

A large electrocoating primer system replaced conventional air spraying at Whirlpool Corp. following an extensive lab project. The objective was to improve productivity and quality of prime-coated cabinets for home washing machines and conform to EPA regulations.

The huge multiple-floor installation consists of two 250,000-gallon tanks and a 50 fpm conveyor system. Sheet metal washing machine cabinets are conveyed through the primer while an electrical charge attracts it to all internal and external areas. Except for evaporation losses, material utilization is complete.

**Cost vs. Process.** Higher paint costs are causing users to investigate alternate materials and/or processes. Owatonna Tool Co., Owatonna, Minn., typifies an efficient paint operation which nonetheless is becoming more concerned with material costs. It utilizes a flexible Ransburg twin-disc electrostatic system and paints over 2000 different parts. With 112 colors used, about 30 color changeovers are made daily.

Operated on a two-shift basis, the electrostatic system paints

parts ranging from thin sheet metal one-half-inch-sq to extrusions over 7 ft long, at 90 to 95 percent efficiency.

Why then is Gary Melder, paint department manager, concerned with alternate materials and/or processes? "Our customers are balking at cost increases for painting. Some claim a cost increase should provide an equal improvement in quality," he relates. "Unfortunately, many fail to realize, or are not fully aware of, the tremendous cost increases of painting materials. The price of some solvents has more than doubled, and one brand of paint has climbed from $4.60 to over $15 a gallon. Environmental regulations have also raised our costs, and the about 40¢ per gallon disposal cost of solvents is becoming prohibitive.

"We are researching water reducibles, water soluble, high solids, and powder coating. However, the majority of water base paint materials fails to pass our 300-hour minimum salt spray, humidity, and weather exposure specifications. The high solids are too new to accurately compare for our type of operation."

**Powder Coating.** He is also investigating the potential use of powder coating. "Powder coating," he explains, "affords a superior surface finish, exceeding our specifications, and its about 300 percent cost increase over conventional paints is impossible to economically justify.

"Yet, the continually increasing costs of paints is making powder coating more attractive. We are hoping for a major breakthrough by powder suppliers or an indication of customer willingness to pay for the better coating it would provide. At that point, we'll purchase a system.

"There are several additional limitations which preclude our using powder coating at the present time. One major drawback is the few available colors—we need over 100. Equipment changeover time is a major problem—a powder system requires about one hour compared to six to seven minutes with conventional paint. Powder coating's excellent bonding characteristics also present problems in stripping racks or coated parts that need rework. New rack-stripping facilities would be required, and trying to strip instead of scrap small low-cost parts makes the economics highly questionable at this point."

One of the largest manufacturers of replacement auto parts recently installed a new DeVilbiss electrostatic powder coating system to improve the appearance of exhaust tail pipes. Initially selected to eliminate exterior rust of the parts, the system also provides an excellent opportunity for better brand identification. Presently, however, tail pipes are coated with a neutral color similar to the color of steel.

The new 10-gun powder coating system, coupled with an in-line two-stage washing machine, randomly processes the maker's entire range of tail pipes ranging up to about 10 ft long. Tail pipes, suspended vertically on a 25-fpm monorail conveyor, are moved from the washer-dryer machine past five permanently mounted spray guns on each side of the conveyor. Staggered in the up-down direction, the spray guns are aimed in the direction of parts travel creating a powder fog which has excellent covering characteristics. A built-in reclamation system affords nearly 100 percent utilization of the material.

**Degreasing.** Developments in liquid cleaning degreasing equipment, along with solvent refinements, are aimed at meeting EPA regulations and alleviating shortages. Wider applications, custom-engineered degreasers, and the utilization of standard recovery stills for continuous distillation of fluorocarbon solvents are among the trends in conservation and cost reduction.

Switching from fluorocarbon solvents to aqueous cleaning solutions helps a user conform to EPA requirements but usually involves substantial cost for rebuilding the degreaser. Aqueous solutions are corrosive and require higher temperatures necessitating the replacement of piping, temperature controls, cooling oils, etc. Such revamped units, furthermore, consume more hot water and, thus, require more input energy.

On the other hand, while fluorocarbon solvents are predicted to remain in ample supply for the next five years, their costs are expected to increase by 15 to 25 percent. Facility modifications for emission elimination may, in numerous instances, prove the most economical long-range solution to degreasing operations.

The following tips from Baron-Blakeslee Co., meanwhile, can help users reduce solvent costs:

- Add a mylar roll cover on open degreasers to reduce evaporation and heat losses;
- Follow a strict maintenance schedule; sludge build-up reduces the degreaser's efficiency;
- Install a recovery still to gain the maximum solvent recovery; overcooking significantly reduces the percentages of solvent recovery;
- Use a degreaser with the correct capacity—too small a unit is overworked and too large a unit is inefficient.

**Vibratory Finishing.** The vibratory finishing process provides major opportunities for cost reductions and quality improvements for deburring, descaling, surface finish refinement, part washing, and drying operations. Today, vibratory finishing machines and supplies are approaching a $35-million annual business. And, with relatively low cost equipment and low labor content per operation, growth in applications is expected.

Mechanized deburring is the

The Ingersoll-Rand Approach to Metal Finishing

# HOW TO EVALUATE HIGH PERFORMANCE PORTABLE GRINDING FOR METAL CLEANUP

By Ray Sponsler
Marketing Manager, Industrial Tools

Will high performance portable grinding really help *you* to narrow the productivity gap—to get maximum efficiency from each man-tool unit?

This recently developed "Metal Removal Evaluation Work Sheet" is designed to provide the answers.

Developed by Ingersoll-Rand, the sheet allows users of conventional-speed portable grinders to compare their present method with performance of air-powered tools such as Ingersoll-Rand's Series 43FH vertical high performance grinder. It considers all variables involved while documenting on-the-job performance of the grinders: type of grinder, cost and number in use; abrasives; actual amount of time the grinders are used (studies by I-R indicate that this "use factor" averages 60 percent); work output; labor and overhead costs.

Tests we've conducted have confirmed that high-performance grinding allows an operator to actually remove more metal in a given period of time while expending less energy than required by conventional grinding.

For instance, our 43FH grinder removes up to 50 percent more metal in a given period of time than any conventional-speed grinder. The unit has a maximum of 4 hp at rated speed and weighs just 11½ lbs. At 8000 rpm, the 43FH with a 6" cup wheel produces an abrasive speed of 12,500 surface feet per minute. With a 9" depressed center wheel its rate soars to 19,000 sfm.

An exclusive "center shift" governor on the 43FH, and on all of our other high performance grinders, provides maximum horsepower at a higher working speed, allowing the wheel to turn faster and remove more metal.

A special overspeed device on all of these tools shuts off the grinders at 20 to 30 percent over governed speed in case the tool overspeeds due to abuse or maladjustments. In addition, special-thread arbors prevent accidental mounting of conventional grinding wheels that might disintegrate at the high speeds of the 43FH and other high performance tools. Added operator protection is provided by extra heavy-duty wheel guards.

A simple formula at the end of our Metal Removal Evaluation Work Sheet converts comparative cost factors into potential savings obtainable with high-speed grinding.

Ingersoll-Rand

**METAL REMOVAL EVALUATION WORK SHEET**

Work Station _____ Date #1 _____ Date #2 _____

Material to be Ground _____ Type of Grinding _____

| | Present Method I | | High Speed Grinding II | |
|---|---|---|---|---|
| 1. Type of Grinder | | | | |
| 2. Grinder Coat | | | | |
| 3. No. Grinders in Use | | | | |
| 4. Air Pressure at Grinder while operating | | | | |
| 5. Hose Size | | | | |
| 6. Wheel Brand | | | | |
| 7. Wheel Grade | | | | |
| 8. Wheel Size | | | | |
| 9. Wheel Price | Maximum | Minimum | Maximum | Minimum |
| 10. No. Wheels Used/Shift | | | | |
| 11. Use Factor—Actual Grinding Time | | | | |
| 12. Work Output/Shift | | | | |
| 13. Cost/Shift (Labor & Overhead) | | | | |
| 14. Wheel Cost/Shift (Wheel Price x No. Wheels Used) | Maximum | Minimum | Maximum | Minimum |
| 15. Cost Pc = Line 13 + Line 14 / Line 12 | | | | |

16. Savings/Shift = (Cost/Pc II – Cost/Pc I) × (Work Output II – Work Output I) =
a. Max Wheel Cost _____ b. Min Wheel Cost _____
17. Total $ Savings/Day = No. Grinders × $ Savings/Shift × No. Shifts =
a. Max Wheel Cost _____ b. Min Wheel Cost _____
18. Annual Savings = Total $ Saving × 240 Working Days = a. _____ b. _____
19. Cost New Method = No. Grinders × Grinder Cost _____
20. Actual $ Savings First Year = Annual Savings – Grinder Cost =
a. Max Wheel Cost _____ b. Min Wheel Cost _____

When grinding costs were becoming noticeably higher at AMF Beaird, Inc., Shreveport, La., the firm switched from conventional-speed tools to Ingersoll-Rand 22FH and 43FH grinders. Now four operators do the grinding that previously required as many as six operators, relieving those other operators for other jobs. Grinding time per unit is reduced by an estimated minimum of 15 percent. The lighter weight of these new tools also reduces operator fatigue. Natural-grasp, comfortable handles contribute significantly to higher man-tool capacity over a full shift at AMF Beaird.

Mobile Pulley & Machine Works, Division of Lehigh Valley Industries, Mobile, Ala., is an international supplier of large, heavy duty pumps, pump components and other equipment used primarily in the dredging industry. This firm reduced grinding time 45 percent with a 31HL80 and a 43FH Vertical High Speed Grinder from Ingersoll-Rand. Wheel wear was reduced 33 percent. Total abrasive wear was reduced 40 percent. Metal Removal rates were increased many times, greatly increasing the potential for savings on individual jobs.



INDICATE NO. 239 ON BUSINESS REPLY CARD

**A new compartmented vibratory deburring machine eliminates nicking and/or breaking of fragile parts**

largest and most active area for the vibratory finishing equipment makers. And improvements in the process are providing large-scale cost savings for users. The process is applicable for both low- and high-production operations, and recent technological developments make mechanical deburring economically feasible for high-precision machined parts without changing their dimensional characteristics.

Among equipment builder developments are larger and more sophisticated machines and controls. Integrated in-line deburring systems are becoming an economical and efficient replacement for time- and labor-consuming batch-type operations. Automated loading-unloading and material handling to and from the deburring machines contribute to these higher levels of productivity.

Among recent developments is the Roto Finish Spiratron II vibratory deburring finishing machine whose most noteworthy feature is separate moving compartments around a torroidal chamber. This permits deburring of parts of virtually any type material without nicking or breaking. Ranging from 4- to 100-cu ft capacity, these machines handle parts from ¼ in. to about 36 in. long.

An unusual feature of the Spiratron II is an infinitely variable and adjustable cycle and sequence timer. This provides cycling compatibility for in-line operations; the machine can be matched to preceding or subsequent manufacturing operations. A self-contained media retrieval system contributes to extending the media life up to 50 percent.

One of the first new 100-cu ft units is in operation at a German automotive plant deburring a wide variety of parts including stampings, die cast pump housings, and engine camshafts. It reportedly is exceeding the initial cost reduction and productivity improvement expectations.

Richard D. Taylor, president, Roto Finish Co., comments on why his business grew 31 percent last year and why he expects it to double during the next four years: "The increased business will come from manufacturers switching to vibratory deburring equipment, upgrading their processes, and finding broader applications for it. Additionally, some manufacturers are switching to vibratory machines for descaling, refining and polishing of surface finishes, and part washing.

"Vibratory machines for part washing operations provide an excellent opportunity for king-size reductions of both facilities and manufacturing costs. The installed cost of a Spiratron machine capable of washing 26 cu ft of parts per hour is 50 percent less than that of conventional through-feed washing machines. Additional savings come through elimination of heating energy, water consumption, and maintenance."

Keith A. Fligge, sales manager, Almco Queen Products Division of King-Seeley Thermos Co., agrees that "there's been a trend by manufacturers toward new applications of mechanical deburring to reduce costs and obtaining improved and consistent quality.

"Most of the new applications require larger and more sophisticated equipment. And, additionally, our customers are demanding high-quality equipment with extended reliability. To answer this need, we are engineering and building larger, more rigid equipment.

"Other quality features include urethane tub liners, variable-speed drive mechanisms, and

# Planning to join the exodus to water reducibles?

A growing number of manufacturers see water-based finishing as a way to escape the pollution problems and hazards related to the use of volatile solvent materials. Water reducibles eliminate more than 80 per cent of volatile solvents, provide a top quality finish at low cost. Little wonder that the tide is moving favorably toward water reducibles.

Before you decide on finishing equipment, why not consider combining the big benefits of electrostatic spraying with those of water-base materials?

An electrostatic system offers greater efficiency. It provides a wraparound spray with an affinity for the workpiece. Thus, most of the material is used rather than collecting in the booth or going up the stack.

Then, consider the benefits of a NORDSON system:

(1) Simplicity of design which makes the equipment easy to install; and

(2) Safety feature which incorporates an integral, automatic interlock device to eliminate the need for elaborate, expensive in-plant isolation and complex warning systems.

**Nordson offers automatic or hand systems. Which one best meets your requirements?**

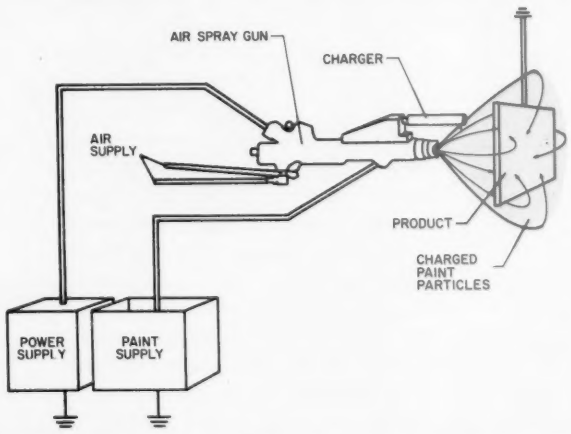



*Diagram of Nordson NAE-4A for automatic electrostatic spraying of water reducibles.*

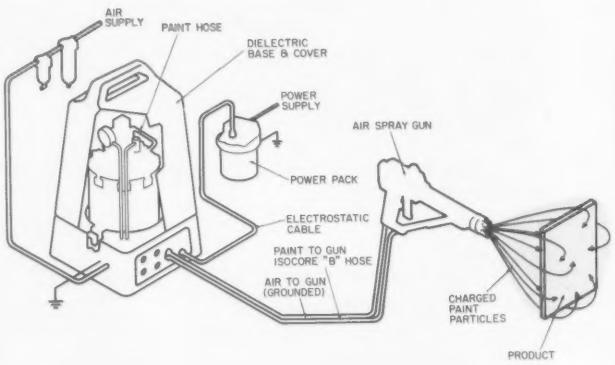



*Diagram of Nordson NAE-6M, manually operated, air atomizing electrostatic system for water reducibles.*

# Check into an electrostatic system by Nordson

Write for Product Bulletin No. 12. NORDSON CORPORATION, 87 Jackson Street, Amherst, Ohio 44001. Phone 216-988-4471. Also available in Canada, Mexico, Europe, Asia, Australia, South Africa, and Japan.

Nordson®

*For Better Ways to Apply Coatings and Adhesives*



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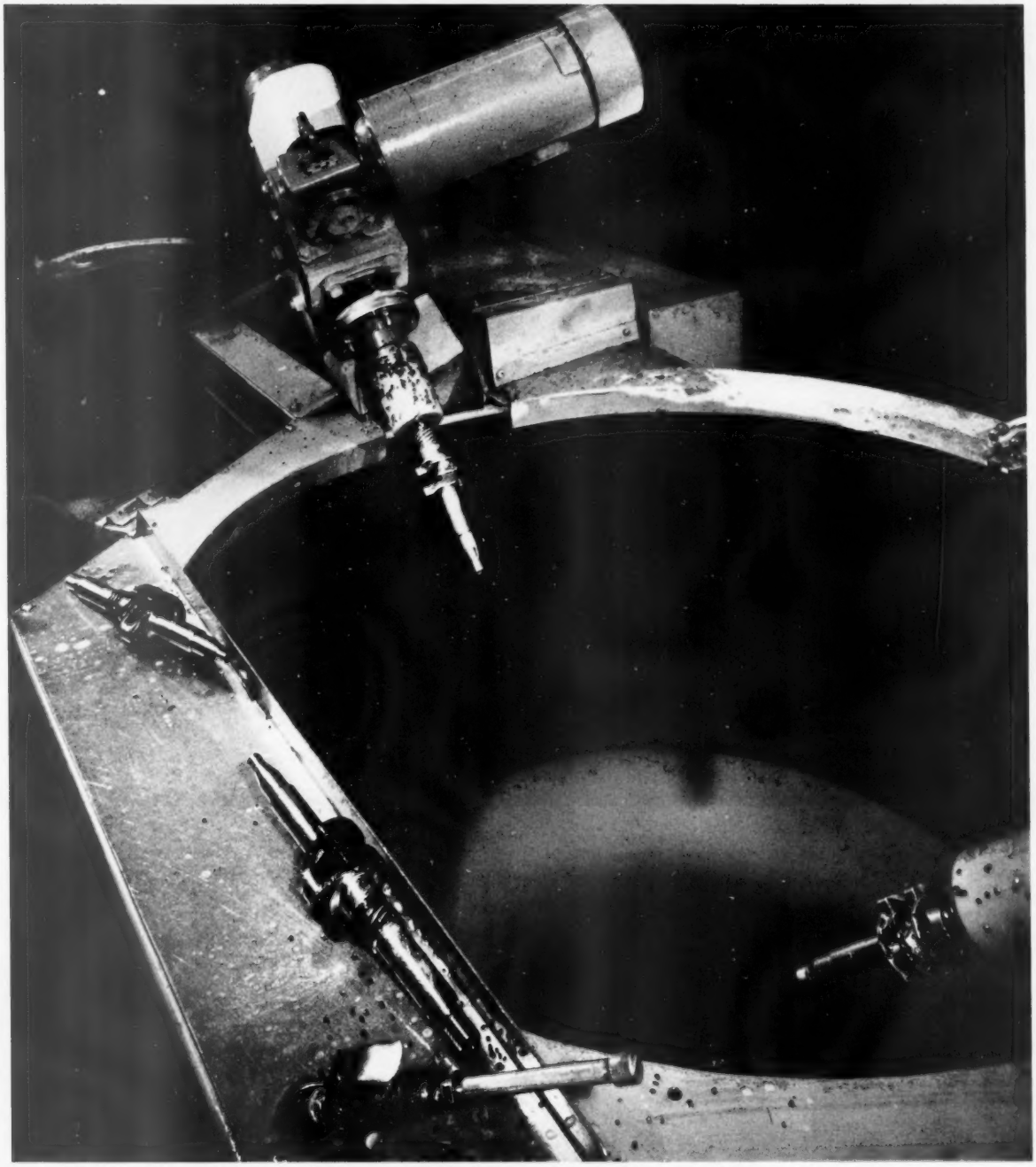


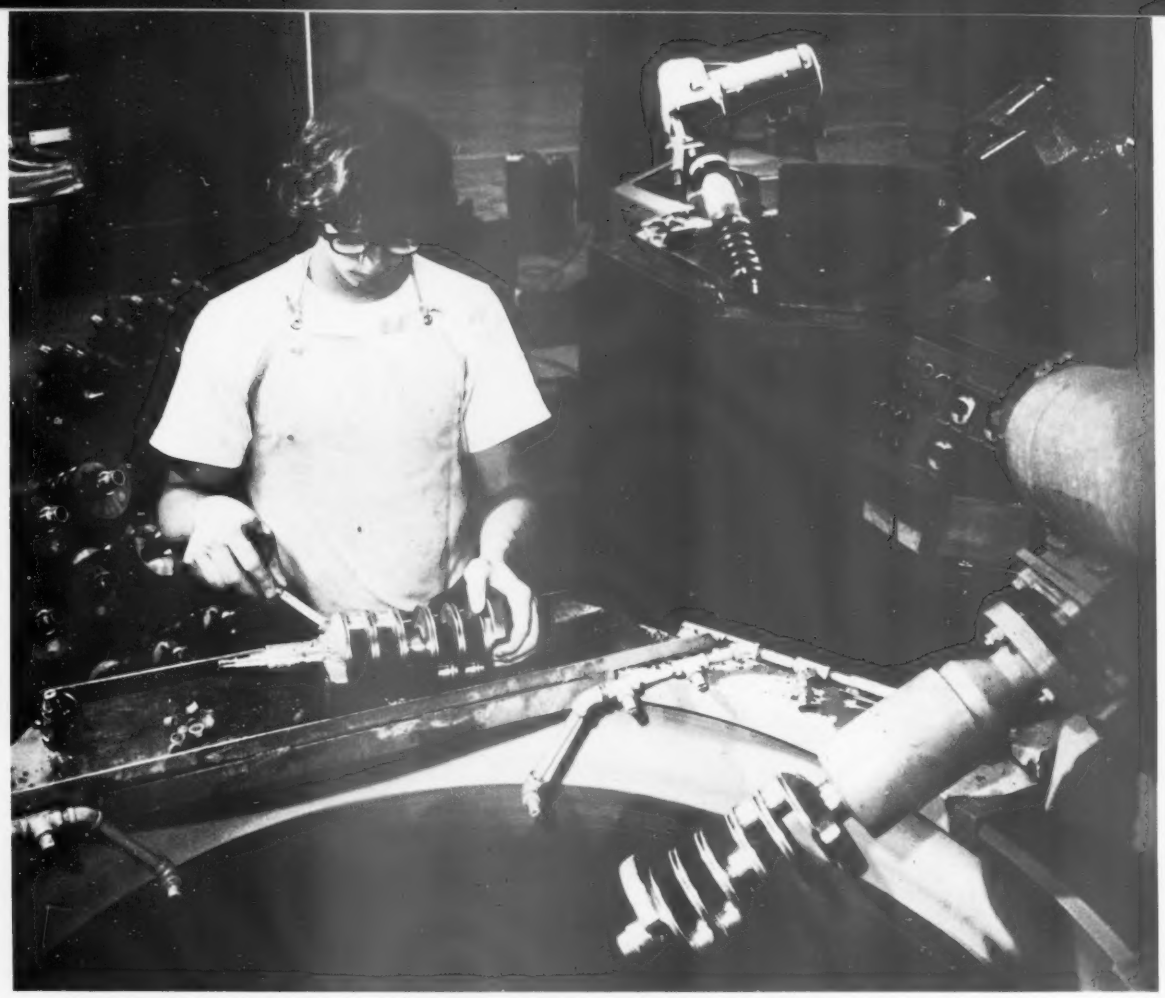
**One of Evinrude's new machines deburrs small crankshafts for lawnmower gasoline engines**

mechanical load-unload devices. Also, the reliability of Almco equipment has been improved to operate 10,000 hours without major maintenance."

These changes, he points out, have, however, increased equipment cost considerably. An average deburring machine presently costs about $15,000 compared to perhaps $5000 ten years ago.

He notes also that significant improvements in media are contributing to more successful deburring operations. Plastic media is rapidly gaining wider acceptance for specific applications. Usually it proves superior for pre-plating clean-up for delicate fragile parts. Liquid compounds are also becoming popular. Basically, phosphate-free, biodegradable liquids mixed with water are used to clean, descale, lubricate, and burnish production parts.

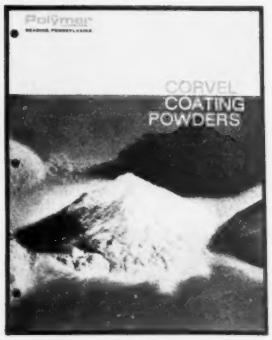
To manufacturers looking for a panacea, he adds a word of cau-



**Operator inserts a plastic plug into an oil hole of a 50-lb outboard motor crankshaft to keep the deburring media out**

# USEFUL LITERATURE

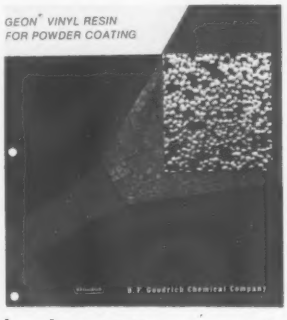
**A 26-page brochure** outlining its extensive line of Corvel coating powders includes decorative formulations. These powders are formulated for electrostatic spray applications. Lists advantages of plastic coating powders over conventional coating materials. **(Polymer Corp.)**
*Indicate No. 768 on card*



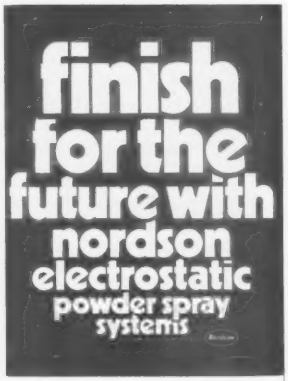

**A plasma gun system for spraying** a wide variety of low- and high-temperature plastic powder coatings on metals, ceramics, glass, etc., is described in a 4-page brochure. **(Sealectro Corp.)**
*Indicate No. 764 on card*

Sealectrocote II
PLASMA GUN SPRAY SYSTEM
A Single Step Process for Spraying a wide variety of low and high temperature plastic powder coatings on metals, ceramics, glass, glass, wood.
SEALECTRO

**The steps involved in compounding and applying vinyl powder coating** compounds by fluidized bed dipping and by electrostatic spray methods are described in a 12-page bulletin. **(B.F. Goodrich Chemical Co.)**
*Indicate No. 767 on card*




**What you should know about powder coating** is described in a 12-page brochure which presents the four "E's": economy, ease of application, excellence of finish, and ecology. **(Nordson Corp.)**
*Indicate No. 766 on card*




**A 6-page guide** to the DuPont family of Freon fluorocarbon

tion: "Mechanical deburring is not a cure-all, or a crutch for a poor manufacturing operation. The process will remove legitimate burrs economically and efficiently, but it will not remove extruded parent metal."

Evinrude Motors Division of Outboard Marine Corp. is an example of an organization making its first major venture into mechanical deburring. It recently purchased six new Almco dual-spindle machines. Four are in operation on a one-shift basis producing the volume which previously required a three-shift operation. The remaining two machines are slated for delivery in the immediate future.

Small crankshafts for lawn mower engines are deburred two at a time in a pair of the dual-spindle machines. The manually loaded crankshafts are air-chucked and submerged to revolve in a media consisting of aluminum oxide and a liquid compound. Deburring involves breaking all sharp corners and edges around a keyway. Two parts are produced per machine in an 80-second cycle. Previously, three to five bench deburring operations were required.

Larger-size 50-lb crankshafts for outboard motors are similarly deburred in two larger special deep-tub Model SF48AS machines. Each machine produces two deburred crankshafts in a three-minute cycle.

**Plating.** Last year Udylite Corp. made three major contributions to the plating industry: a new process for chrome plating plastic; faster and more economical hard-chrome plating; and a new metal reclamation service.

The new UDIQUE plastics chrome plating process provides a consistent high-quality surface at minimum cost. Basically, it is a five-step process: etch, neutralize, activate, accelerate, and nickel electroplate. A contract plater currently is gaining the quality benefits from the process for a wide variety of plastic parts from appliances to salt shakers.

The Chromolyte Ultrachrome ACF process provides a productivity improvement of 25 to 40 percent for hard chrome plating operations. Capable of plating 3 to 4 mils at 4 amps per sq in., the process affords a harder, brighter plated surface. This process is being used by an agricultural equipment manufacturer for a variety of parts including hydraulic piston rods. Benefits include reduced plating costs and improved product reliability.

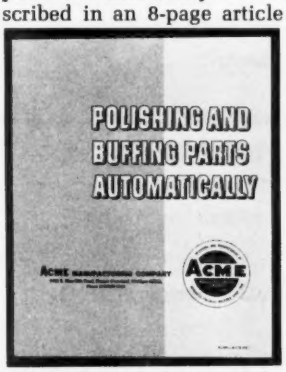
Udylite's metal reclamation group provides a new service that can reduce the cost of plating materials up to 50 percent. It reclaims the metal ordinarily lost in rinse, spent, and metal stripping solutions. Through an arrangement with platers, Udylite recovers the metals and recycles them into solutions for reuse.—*VAW*

cleaning agents *(indicate No. 769 on card)* and a 4-page brochure describing a defluxing system using Freon solvents for removing stubborn flux residues are offered by DuPont. **(DuPont Co.)**
*Indicate No. 770 on card*

**An 8-page guide to the chemical treatment of metals** lists

the complete line of Amchem chemicals, showing their method of application, advantages, and characteristics. **(Amchem Products, Inc.)**
*Indicate No. 773 on card*

**Polishing and buffing of parts automatically** is described in an 8-page article




that deals with design of the product, the desired production rate, and the equipment available. **(Acme Manufacturing Co.)**
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**Ultraviolet curing of printing inks and other coatings** including wood and metal coatings and particleboard fillers is described in a 12-page illustrated booklet. **(Conrad-Hanovia, Inc.)**
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**How to evaluate Sonic energy cleaning equipment** is outlined in a 12-page illustrated brochure. **(Bendix Corp.)**
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**Why airless spray systems achieve better product finishes** and reduce finishing costs is explained in a 20-page brochure. Four types of systems are explained. **(Nordson Corp.)**
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**How to spray metal coatings on fabricated workpieces,** using coating metal in wire or powder form, is described in a 26-page brochure. **(Mapp Products)**
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**Effective methods for cleaning stainless steel** are described in a folder chart listing cleaning agent, method of

application, and effect on finish. **(Republic Steel)**
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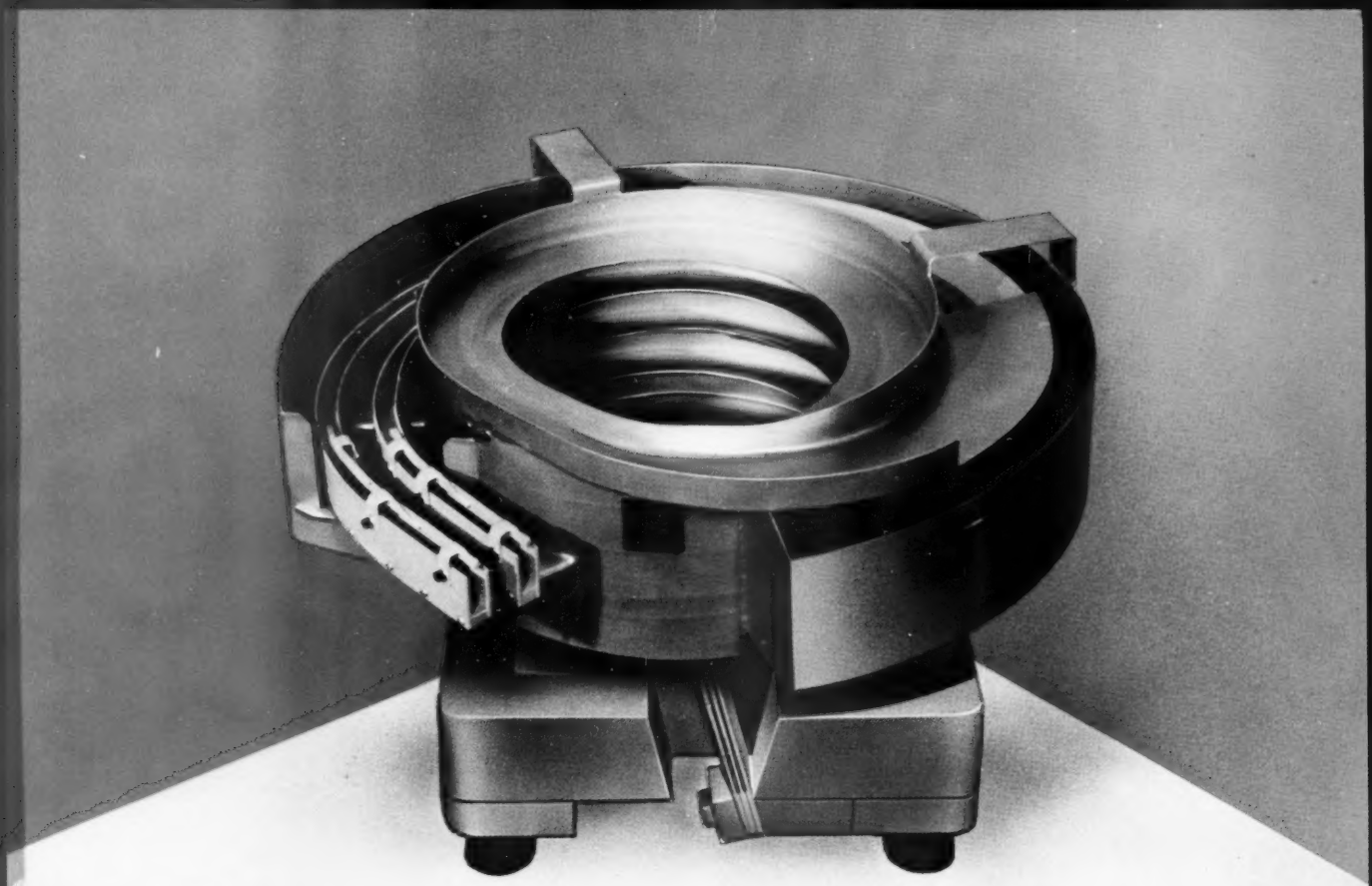

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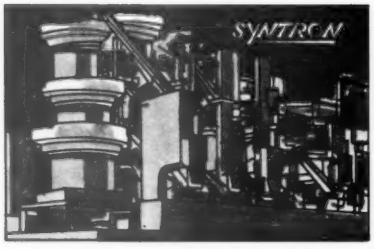
What's behind our super bowl is as important as what goes into it. How's this for back-up:

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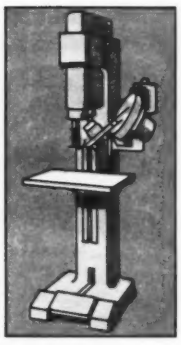

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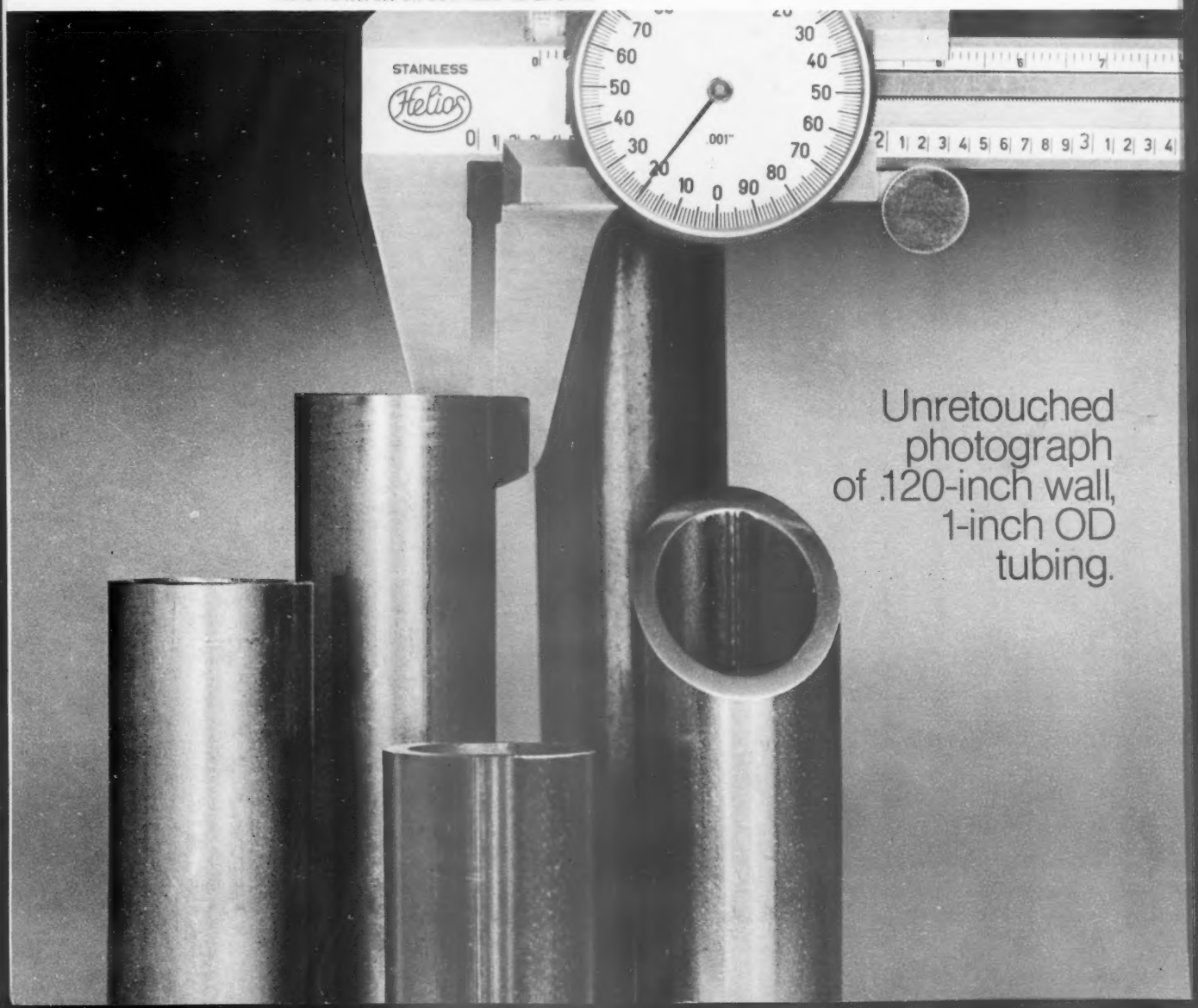


Unretouched photograph of .120-inch wall, 1-inch OD tubing.